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CRITICAL ANALYSIS OF WALKING ON DIFFERENT SURFACES ON SELECTED MOTOR FITNESS PHYSIOLOGICAL AND BIOCHEMICAL VARIABLES AMONG OBESE MEN

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IN
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Dr M Shunmugakumar

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Dr MGR Educational and Research University

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A THESIS

Submitted by

SHUNMUGAKUMAR M

in partial fulfillment for the award of the degree
of
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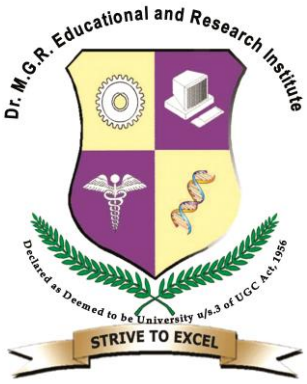

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ABSTRACT

The aim of this study was to provide three different surfaces to sensitize male population about the other physical activities which may contribute for their fitness avoiding monotony of activity thereby helping them to find peace and immunity, improved abilities and processing efficiency with their abilities and skills. The scholar tried mud surface to one experimental group, road surface to the next experimental group and a concrete surface to another experimental group. It would contribute to the society at large to have a healthy and active life if the experiments in the study are proved encouraging and the prescription of the best surface for walking would benefit the society at large.

The aim of this study was to find out the different surfaces walking on motor fitness, physiological variables and biochemical variables among obese men, that too which surface was giving more impact and more benefits for the normal, middle class people. Because who are all rich they go for gym and they walk in their home itself with the help of treadmill. This study would contribute to the society at large to have a healthy and active life if the experiments in the study are proved encouraging.

In the present study an effort was made to select the subjects among the obese people from Chennai city, Tamil Nadu. The subjects were directed to assemble in a park to seek their willingness. The investigator explained to them the purpose, importance of experiment and the procedure to be employed to collect the blood. Further, the role of subjects during experimentation and testing period were also explained. Hundred and twenty subjects were selected by random sampling technique. Their age ranged from 40 to 45 years. All the subjects were over healthy. The subjects were divided in to four equal groups of thirty each at random method. There were no dropouts in the study and the entire subjects cooperated well during the experimentation and testing periods.

1. To explore the improvement on chosen To find out the effects of Walking on different surfaces on selected Biochemical, Motor fitness and Physiological variables among obese men.

2. To examine how far the experimental group experienced changes on motor fitness selected and physiological, Biochemical, variables during the training period.

The criterion variable selected in the study Bio chemical, Motor fitness and physiological variables. i) Random blood sugar ii) Low density lipoprotein iii) High density lipoprotein I) cardiovascular endurance, ii) Flexibility, i) resting pulse rate ii) vital capacity and the standard test were used to asses these variable.

The experiment was conducted for a period of 12 weeks and the data on the selected variables were collected before and after the experimental period and the collected data were analyzed using ANCOVA and the mean differences among the pre and post tests of the variables were established.

It has been scientifically accepted that any systematic training over a continuous period of time would lead to produce changes on athletic qualities. Based on this concept and research questions the following research hypotheses were formulated and it was tested at 0.05 level of confidence. On the basis of the study the following conclusions were drawn:

The Resting Pulse Rate was significant at .01 level of confidence with an F- ratio of 10.09. It explained that the mean differences were not occurred due to chance but they differ significantly. The obtained values of F' ratio between Mud Walking group and the control group was 23.34 which is highly significant. The obtained values of F' ratio between Road Walking group and the control group was 15.12 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 2.43 which was well below the required level of confidence.

The cardiovascular endurance was significant at .01 level of confidence with an F-ratio of 5.14. It explained that the mean differences were not occurred due to chance but they differ significantly. The obtained F- ratios between the Mud Walking group and the control group were 14.30, the Road walking Group and the Control Group was 7.03 and the Concrete Walking Group and the Control Group was 4.83. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 14.30 which is highly significant. The obtained values of F' ratio between Road Walking group and the control group was 7.03 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 4.83 which was well below the required level of confidence.

The vital capacity was significant at .01 level of confidence with an F- ratio of 23.22. It explained that the mean differences were not occurred due to chance but they differ significantly. The obtained F- ratios between the Mud Walking group and the control group were 67.06, the Road walking Group and the Control Group was 22.92 and the Concrete Walking Group and the Control Group was 14.00. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 67.06 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 22.92 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 14.00 which was well below the required level of confidence.

The flexibility was significant at .01 level of confidence with an F- ratio of 30.17. It explained that the mean differences were not occurred due to chance but they differ significantly. The obtained F- ratios between the Mud Walking group and the control group were 78.27, the Road walking Group and the Control Group was 30.88 and the Concrete Walking Group and the Control Group was 8.56. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 78.27 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 30.88 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 8.56 which was well below the required level of confidence.

The random blood sugar was significant at .01 level of confidence with an F- ratio of 10.47. The obtained F- ratios between the Mud Walking group and the control group were 33.25, the Road walking Group and the Control Group was 15.41 and the Concrete Walking Group and the Control Group was 8.52. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 33.25 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 15.41 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 8.52 which was well below the required level of confidence.

The variable low density lipoprotein was significant at .01 level of confidence with an F- ratio of 4.4. The obtained F- ratios between the Mud Walking group and the control group were 12.68, the Road walking Group and the Control Group was 9.35 and the Concrete Walking Group and the Control Group was 3.24. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 12.68 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 9.35 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 3.24 which was well below the required level of confidence.

The high density lipoprotein was significant at .01 level of confidence with an F-ratio of 13.19. The obtained F- ratios between the Mud Walking group and the control group were 33.55, the Road walking Group and the Control Group was 22.05 and the Concrete Walking Group and the Control Group was 9.66. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 33.55 which is highly significant. The obtained values of F ratio between Road Walking group and the control group were 22.05 which were also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 9.66 which were well below the required level of confidence.

On the basis of the findings of the study, the following recommendations were made:

1. This study with a large population might bring out more insight into the selection o f surfaces for walking.
2. The intensity of walking had not been very much followed in the current study and that could be taken with another study with different age group.
3. The same study could be done among school boys and girls
4. The study could be restricted to obese adolescent boys and girls with addition of diet regulation and walking intensity.
5. The fitness trainers, coaches and physical educators could recommend for people to walk on mud surfaces for better results.
6. All the parks in the city should have a firm mud path for walking instead of concretizing the paths for the sake of less maintenance.

7. The schools and colleges should make it known to their students that mud walking would yield better result for fitness improvement.

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M. SHUNMUGAKUMAR

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LIST OF SYMBOLS AND ABBREVIATIONS

ACSM	American College of Sports Medicine
CHD	Coronary heart disease
CRF	Cardio respiratory fitness
CV	Cardiovascular
DARE	Diabetes Aerobic and Resistance Exercise
DREW	Dose Response to Exercise in Women
ET	Exercise training
HART-D	Health Benefits of Aerobic and Resistance Training
HF	Heart failure
MET	Metabolic equivalent
PA	Physical activity
STRRIDE	Studies of a Targeted Risk Reduction Intervention through Defined Exercise; T2DM; Type 2 diabetes mellitus
PA	physical activity
(GLP-1)	glucagon-like peptide-1
(GIP)	glucose-dependent insulinotropic polypeptide
QoL	Quality of Life
(ExEE)	energy expenditure
(FMS)	Fundamental Motor Skills
(HRR)	heart rate recovery
(EPOC)	excess post-exercise oxygen consumption
RPE	rating of perceived exertion
FVC	Forced vital capacity
FEV1	forced expiratory volume in one second
CATCH	Community Approaches to Cardiovascular Health

PATH	Pathways to Heart Health
BWSTT	body-weight-supported treadmill training
CAD	coronary artery disease
IOTF	international obesity task force
CDC	centre for disease control

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AND INCORPORATIONS AS DETAILED BELOW

S.No	Examiner's comments and Suggestions	Corrections done in page Number.
1	Printing Errors in Page No 28 line 4 and 5	Corrections carried out in Page Nos. 27 and 28
2	Information regarding Ethical clearance is not found	There is no Ethical clearance board in our University and hence ethical clearance was not followed
3	In Page 58, interchange of columns in Table – 1	Page No. 58
4	It will be nice if the scholar inserted the pictures of the participants who involved in the present study and may enhance appropriateness for this study	It was not possible to take pictures of participants s they requested not to show their photos. To keep their identity and their data confidential their photos were not taken.
5	The load dynamics should have been included in this chapter.	Since the subjects were obese males of age between 40 to 45 years, many with diabetes and blood pressure, could not be pressurized with load progression and prescribe intensity levels. They were demanded only to walk for 45 minutes five days a week.

Chapter 1

INTRODUCTION

Every human being has been blessed to move inside the wombs and kicked their mothers from inside. The mother was happy when the child moved from inside. The movement was very much instinctive and nobody told the child to move. It was a movement of life and even after birth, the child learns all its movements by itself. It is called the big muscle activity of the child. Turning into the belly, crawling with the belly, walking on all the four and standing slowly by itself by leaning over a wall and holding a structure were all performed by the child itself. No one told the child to do so. It was all the natural activity of human growth and development.

Now that the child listens to his playmates, parents and teachers, it acquires lot of knowledge. But the science and technology has played a vital role in making the child less active. Comparing the children before 25 years to the children of today, a lot of differences in the way they lived and how today they live are found. Walking to school has become a ride by automobiles with their parents. Living in a large house in a joint family and playing after the school with the friends has been reduced to play within four walls without any companion and slowly it led to play with electronic gadgets. Now the children spend a lot of time sitting, playing and eating before the television sets. Eating a nutritious breakfast with locally available grains and fresh vegetables from their own gardens have been converted into eating tasty junk food and vegetables of all kinds of chemical fertilizers and pesticides. Eating with the family members has been reduced to eat alone due to the nature of the employment of the parents.

The natural way of learning swimming in the lakes and ponds are gone today. Climbing trees and chasing one another is lost today. So, the change towards the evil is not sudden and immediate. Without our knowing that we are moving towards a path of danger and inactivity we have come to a stage that we are today. Mother thinks that the work in the kitchen is enough exercise for her. Father thinks that the job requirement and his

activity is enough for him. But when they realize that they have gained weight and accumulated fat around their hips and become obese, they get a lot of physical problems. When they consult a doctor, the doctor advises them to have exercises or at least to walk daily. When they try to walk with heavy body, they don't find it pleasant and they give up but eat as usual. They never realize that it is vicious circle and only when they come out of that by breaking it, and then only it is possible for them to have a happy and problem free health.

The path chosen by the ultramodern human society is perilous. Without knowing the impact of their life style changes that have taken place within a span of 25 years, they adopt to the dangerous conditions of life. These are all caused by three fold areas of activities. One area of the problem is the personal changes in the habits and practice of living, like sedentary way of life. Getting up late in the morning and not doing any exercises in the early hours before going to the job. They prefer not to walk and just use their bikes even to go to a small distance for buying milk and vegetables. They do not want to sweat and consider sweating as a discomfort. Secondly, the food they take does not conform to their health standard. When they are hungry, they eat what they like and what is available. Many households have no time to prepare food at home since both husbands and wives are employed. They stock pile the packed food items and they just like that use those food stuff without bothering about the quality of the stuff due to the addition of chemical preservatives for a longer shelf life. They share the same food with their children and thereby they become the reasons for spoiling health of their own children right from very young age. The third reason is that they find some reason or other either to skip their food and not taking their food on right time. Late and untimely consumption of food is one of the major causes for many life style related health problems.

I wish to present here a narrative of a person who wants to be fit and her passionate narration. The following episode is an excellent eye opener for those who are desirous of doing some exercises to keep themselves fit. Many a cousin, aunt and uncle in her family was a fitness freak. From walking and running to cycling to yoga to dancing, to kalaripayattu, to mountain-climbing and mountain-biking, they did it all. In fact, they couldn't go without it for a single day. And then, there was she. She jokingly said that she was a yoga person; she did her shavasana every single day! To those who didn't know, it was the corpse pose in yoga.

She further added that for most of us, exercise was a huge ordeal. Taking a walk to the nearby shop to buy groceries was mostly replaced by a trip on the motorbike, sometimes even the car. Need to go to the first floor, take the lift instead of the stairs. The easiest excuse anybody came up with: no time. Therefore we do miss out on the simplest flexing of our muscles and joints.

In her case, she loved any kind of physical activity. Except, she needed someone to coax her into it; sometimes a little more forcibly, to the extent of letting them drag her out of her comfort zone, figuratively and literally. Sometimes, though very rarely, the mirror managed to do it. When she looked into the mirror and found that she had had made some really 'flab' friends, she groaned aloud at their sight and made plans to get rid of them quickly.

Or might be that fine day her father remarked that she was getting lazy and fat. With determined enthusiasm and zest, she decided to get back into shape, on Day 1 itself. That's how ridiculous it usually was. Realisation dawned a little late the next day as she went back crawling into bed, sore with pain. Strenuous workout on the first day: very bad idea.

May be sometimes rewards would work just as fine. Back in her undergraduate days her college had the credit system, which would ensure everyone did something apart from academic activities in order to earn their compulsory credits over the three years. She enrolled herself for yoga as a credit course. She managed to persuade a couple of her friends into going with her too. They struggled with the rest of the class as they tried touching their toes, or balancing themselves on one foot (even with our eyes open), or lifting their feet a few centimetres off the ground while lying down. After the initial weeks, their yoga instructor, seeing no improvement at all, finally decided to give them the much-needed quote, "Your legs have been carrying you all these years, and you can't do them a favour and even lift them off the floor for a few seconds? What a shame." Somehow, for her it worked wonders and put things into shape, pun intended.

Subsequently she also signed up for a self-defence class outside of college hours on the assumption that she could get my credits. She worked hard, learnt her katas, fought her opponents, showed off her purple-blue bruises to anyone who'd ask. When her brother forced her into accompanying him for the 'Learn to Swim in 15 days' at a pool nearby, she realised it was the best way to beat the heat and also earn her credits. While it took her

close to 10 days to learn just the basic strokes, her brother had mastered a lot more. As they neared the end of their coaching, she had managed to swim the entire length of the pool from the six-foot end to the four-foot end, a huge accomplishment in itself.

Reverse strategies seem to work for her. A physically challenged coach who had been watching her told her to swim back. She was exhausted and told him that going back would be a bad idea. But he took sheer delight and said that those four- and five-year old kids swam to the six-foot end, and asked her how old she was. Sometimes, it was best to ignore such comments. But her being her, she was fuming with anger for being chided, and decided to swim the reverse stretch. Hardly crossing the five feet mark, she forgot how to use the breathing technique I she was taught. The exhaustion, too, took its toll and it was difficult to stay afloat. She let go, and hit the bottom of the pool. Her mind was shrieking and telling her if she didn't take the one last effort she would lay there until somebody found her. So, she did it, she shoved herself up to the surface, towards the wall of the pool. She survived it. In fact, the coach had rushed another coach to help her after she didn't surface for some time. She was glad for it, in spite of herself. And, if you're waiting to know if she earned those credits: yes, she partially did, only for yoga though; the other two were purely exhilarating experiences that she would love to continue.

Almost four years since, she still waited for that egging and prodding from somebody before she restarted her exercise routine. As of now, she is back on that yoga mat, dutifully doing her suryanamaskar, and the other asanas that she learnt. Shavasana, the ultimate asana that made her appreciate the effort of the sweaty exercise, as she cooled off, was still one of her favourites. She was defending her stand there, so you might want to find out about its benefits before you disagree with her!

A wonderful example of how people desire, attempt and fail, again try and try and succeed in getting rid of the excess weight and to keep the body trim. Effort and loving the pain after exercise only would keep anyone on the routine. If anyone who loves bes and sleep might fail in their attempts. Nothing wrong in their desire to do exercises but the perseverance is the important element. (Ananya 2015).

Now it is very obvious that the problem we face today due to the prevalence of diabetes, hypertension and the like is due to our own activities. They are not infectious and so we have not derived them from anybody else. They are like accidents and they just do not happen but they are caused due to careless approach to our ways of living. We should

understand that health and physical fitness play a fundamental role in the life of human from time immemorial. The progress of the Nation lies in the hands of the people, who are healthy and physically fit. Every individual have to develop physical fitness and lead a happy and healthy life. It is very simple that to get physical fitness one has to involve in physical activities.

Obesity is a social problem which begets many more non-infectious troubles to the body mechanisms. The reasons for this social evil might be attributed to heredity and the host of other habits like over eating and sedentary life styles. The lifestyle changes have played a very great role in many developed countries and the life style changes are ascribed to advancement in science and technology. The science and technology is fulltime striving to provide a better and comfortable life. At the same time the curse of obesity is recognized to the lack of physical work and lack of physical work is linked to the developed and easier comfortable lifestyle.

If the above health hazard is true in urban and semi urban areas in Tamil Nadu, a part of developing India, the same trend is now found very much in prevalent in rural south Tamil Nadu. People have become moderately lazy by sitting in front of Televisions and discussing politics and like. The reasons mainly are pointed to the lack of their farming work. The lack of farming work may be due to the shrinking of cultivable land and the non-productive and loss making agriculture.

The urban and semi urban people who have the knowledge of sedentary life style, the physical problems they get due to their eating habits and laziness, have a lot of guidance and counselling from the medical professional and hospitals. But, the people who live in the rural background, not knowing the reasons of their problems, eat what they get and do not care to visit a doctor and get his guidance.

People are in search of an easiest way to reduce their size, weight and eat less to keep the sugar level in control. But they are not aware of the fact that the simplest way of keeping control over the above problems is just walk. Walking is mindlessly shifting one leg ahead of the other and the speed, intensity and the distance are under the personal control of the walker. If you are in a pleasant mood and energetic, you can walk for 50 minutes faster and cover a distance of 4 to 5 kilometers. If you are tired and not inclined to do more, it is up to you to choose the speed and intensity of your walking and the distance travelled is under your own wish. The people must be aware of the fact that if they walk a

small distance spending more time is almost equal to covering a long distance in short time, in terms of the calories spent.

Taking into consideration walking, a simple form of exercise, in to the fold of their daily routine, the problems of obesity, sugar and other problems could be kept under control. Many researchers strongly support that regular walking helps one keep strong and healthy and prevent cardio- vascular diseases. The heart beats of a physically fit person are lower and pumps more blood per beat at rest. Regular walking increases the individual's capacity of lungs and heart.

Bandopadhyay and Murmu (2015) expressed their opinion that physical education had until recently been considered almost exclusively as a profession providing programs in educational institutions, but was now also an academic discipline with a growing knowledge base whose focus point is to improve human movements. The said that recent scientific reports informed that the whole universe is created through tremendous movement of our solar system and in the same manner the earth was created where we live. So, movement is the inevitable part of this Universe, without movement life does not exist. So, movement is the major theme of physical activity. General fitness is the part of overall health. Being generally fit means having a healthy body weight as well as an ability to perform physical fitness activities without tiring easily. Specific fitness is the opposite of being generally fit. It refers to how well a person is able to master specific levels in a part. General fitness is more about being healthy in a well-rounded way. A general fitness workout could be as simple as working, since it helps in overall health. Brisk walking can provide cardiovascular exercise as well as arm, leg toning. Some people increase the intensity of their general exercise by gradually adding jogging or running to walking workout. Any exercise routine performed to act on overall health is considered as general fitness. While certain arm or leg movements are used as a part of specific fitness training to improve skill in a certain game such as golf or tennis, if done regularly, can have reduce the risks from some disease associated with lifestyle factors. For instances, a genetic predisposition to type two diabetes may lead a person developing the disease, but studies have shown that it may be prevented through proper diet and regular exercise. Regular workouts done to keep the body healthy and resist disease are general fitness oriented. The characteristics and the structure of the coordinative abilities of the athletes are an involved problem of the sport science. The cause for the existing in definition is the lack of theoretic

position in the research of these abilities. Movement coordination may be understood as processed of steering and regulating. The cybernetics- a science for the control of the complex dynamic systems is the most appropriate theoretical basis of investigation the motor fitness abilities.

1.1. Meaning of Physical Fitness

Most authors define 'physical fitness as the capacity to carry out every day activities without excessive fatigue and with enough energy in reserve for emergencies. Emphatically this definition is inadequate for a modern way of life. By such a definition almost anyone can classify himself as physically fit (Gatchell 1977).

Physical fitness is the ability to carry out daily task with vigor and alertness without undue fatigue and ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies. Fitness is a broad term denoting dynamic qualities that allow satisfying the needs regarding mental, emotional stability special consciousness and adoptability spiritual and oral fear and organic health are consistent with heredity. **(**Clarke 1971)

Physical fitness means that the organic system of the body is healthy and function efficiently vigorous tasks and leisure activities beyond organic development, muscular strength and stamina. Physical fitness implies efficient performance in exercises (Bucher and Prentice 1985)

1.2. Benefits of physical fitness

It is necessary for every individual to be physically fit to perform their daily work with ease and to take part in various activities effectively. The benefits of physical fitness are numerous. The person who is physically fit has greater amount of strength, energy and stamina an improved sense of well being better protection from injury because strong well developed muscles safeguard bones, internal organs and joints and keep moving parts limbers and improved cardio respiratory function. (Bucher and Prentice 1985)

1.3. Obesity

Obesity may be defined as an abnormal growth of the adipose tissue due to an enlargement of fat cell size or an increase in fat cell number often expressed in terms of body mass index (BMI). A BMI of 30 or more in males and 23.6 or more in females indicates obesity. The term "overweight" means a weight in excess of the average for a given sex, height and age. Overweight is usually due to obesity but can arise from other causes such as abnormal muscle development or fluid retention. Obesity can occur at any

age, and generally increases with age. Infants with excessive weight gain have an increased incidence of obesity in later life. About one there of obese adults have been so since childhood. It has been well established that most adipose cells are formed early in life and the obese infant lays down more of these cells than the normal infant. Hyper- plastic obesity in adults is extremely difficult to treat with conventional methods. The BMI is calculated by dividing the weight in kilograms by the square of the height in meters.

Obesity is nothing but over weight. The excess body fat has accumulated on total body weight is known as obesity. The term obese is used for very overweight than is considered normal or healthy for ones age or build. The high percentage of body weight has been variously referred to as ideal, desirable or healthy. Body mass index will show the level of fat percentage in our body and the obesity will lead to laziness, blood pressure, diabetes and heart related diseases.

Obesity is a leading avertable cause of death worldwide, with increasing rates in adults. Authorities view it as one of the most serious public health problems of the twenty first century. Obesity is stigmatized in much of the modern world though it was widely seen as a symbol of wealth and fertility at other times in history, and still is in some parts of the world.

The number of person with diabetes is reaching epidemic proportion. From 2000 worldwide prevalence of diabetes in adults is projected to rise by thirty nine percentages. The largest proportional and absolute increase will occur in developing countries. If the people follow the same life style for few more years, than the obesity level will increase like anything in India. Previously, type 2 diabetes was mainly a disease of the middle aged and elderly. But now, the age dose not a matter, who are all having excess weight and if the age is even twenty or less than twenty also they may have type 2 diabetes, because of obesity.

1.4. Classification of obesity

Classification of obesity is done by body mass index (BMI) and further evaluated in terms of fat distribution via the waist–hip ratio and total cardiovascular risk factors. BMI is closely related to both percentage body fat and total body fat.

There is a negative impact of obesity on physical, mental and social functions. Obese child remains obese through their adulthood with various possible risks of adult mortality and morbidity. By giving the importance of growth in early life and childhood

we can prevent risk to future disease. It is vital to precisely monitor childhood growth and determine whether it is adequate or not. There are various sets of growth references but among them three are commonly used to assess the weight status and health risk.

The WHO reported a much higher prevalence of obesity as compared to the other references. The prevalence of adolescent's obesity is dependent on the growth references used. One problem with references is always the question on the golden standard. Moreover the fact that the comparison with the international obesity task force (IOTF) and the centre for disease control (CDC) and the WHO reference give different prevalence estimates prove that these references represent populations between them. Perhaps in this case, it will be more appropriate to develop and use a local reference, in particular for BMI for age, where body distribution of fat might be more genetically determined in the developing country like India. (Banjade et al. 2015)

1.5. Morbidity

Obesity increases the risk of many physical and mental conditions. These co morbidities are most commonly shown in metabolic syndrome, a combination of medical disorders which includes: diabetes mellitus type 2, high blood pressure, high blood cholesterol, and high triglyceride levels.

Complications are either directly caused by obesity or indirectly related through mechanisms sharing a common cause such as a poor diet or a sedentary lifestyle. The strength of the link between obesity and specific conditions varies. One of the strongest is the link with type 2 diabetes. Excess body fat underlies 64% of cases of diabetes in men and 77% of cases in women.

1.6. Causes of obesity

Mainly the combination of unnecessary, excessive food energy and lake of physical activity is most cases for obesity. Sometimes due to genetic and medical reasons may be causes for obesity.

The following reasons also causes for obesity:

(1) insufficient sleep, (2) endocrine disruptors(environmental pollutants that interfere with lipid metabolism), (3) decreased variability in ambient temperature, (4) decreased rates of smoking, because smoking suppresses appetite, (5) increased use of medications that can cause weight gain (e.g., atypical antipsychotics), (6) proportional

increases in ethnic and age groups that tend to be heavier, (7) pregnancy at a later age, (8) epigenetic risk factors passed on generationally, (9) natural selection for higher BMI. This would increase the number of obese people by increasing population variance in weight.

1.7. Management of obesity

The main solution for obesity is diet and physical exercise. Subsequent diet may help to reduce the body weight, but with the help of minimum intensity exercise like walking is help to maintain the weight for long time. Regular walking would assist our body weight in a same level and depends on food on the day, we can increase the level of intensity of the exercise every day, to maintain our body weight. Next most and general treatment for obesity is bariatric surgery. This kind of surgery may help to maintain our weight for long term. But many researchers are found that surgery methods lead to morbidity.

1.8. Physical fitness

Physical fitness comprises two related concepts. General fitness is a state of health and well being. Specific fitness, a task oriented definition based on the ability to perform specific aspects of sports or occupations. Physical fitness is generally achieved through correct nutrition, exercise, hygiene and rest. Our ability to carry out daily tasks and routine physical activities without undue fatigue is called physical fitness.

A comprehensive fitness program tailored to an individual typically focuses on one or more specific skills and on age or health related needs such as bone health. Many sources also cite on mental, social and emotional health as an important part of overall fitness. This is often presented in textbook as a triangle made up of three points, which represent physical, mental, emotional fitness. Physical fitness can also prevent or treat many eternal health conditions brought on by unhealthy way of life or getting old.

Diet is an important component to overall health that works best in combination with exercise. A balanced diet and exercising regularly are important for maintaining good health. Obesity is defined as body mass index, a measure of weight in relationship to height. With obesity on the rise, the U.S. has implemented more exercise and diet plans. There are millions of programs, websites, television shows, magazines, and movies regarding health and fitness. Recently, the trends of diets and lifestyle habits have become more and more encouraged. Understanding the importance of the health benefits resulted

from diet and exercise will help decrease the amount of obesity in this country. Physical activity and exercise is defined in terms of type, intensity, duration and frequency. (Blair 1993)

1.9. Walking

Walking also known as ambulation is one of the main gaits of locomotion among legged animals, and is typically slower than jogging and other gaits. Walking is defined by an inverted pendulum gait in which the body vaults over the stiff limb or limbs with each step. This applies regardless of the number of limbs even arthropods, with six, eight or more limbs, walk.

1.10. Health benefits of walking

Regular, brisk walking exercise improves confidence, stamina, energy, controlling of weight and life expectancy and also reduce stress. Walking also reduces the risk of cardio disease, strokes, diabetes, blood pressure, bowel cancer. Scientific studies have also shown that walking, besides its physical benefits, is also beneficial for the mind, improving brain skills, learning ability. Sustained walking sessions for a minimum period of thirty to sixty minutes a day, five days a week, with the correct walking posture, reduce health risks and have various overall health benefits. Even for individuals suffering from obesity, high blood pressure, and lowering the more harmful low density lipoprotein and raising useful good high density lipoprotein.

When the people venture out for walking, they prefer and choose a nearby park where there will be motivating walkers and a cogent atmosphere. Years back, when the parks were created, the walkers path was made out of mud. Though the ambience was good with plants, trees and grass, the mud path became slushy and unusable during rainy days. Also the mud paths became uneven and rough due to constant and continuous use. When the local bodies felt the pinch I maintaining the mud path, invested a bit more money and converted those mud paths into concrete paths either by laying concrete or by planting tiles and slabs mad out of concrete. Now the path could be used in all the seasons but the health effects were not researched. Many people who walked all along in mud paths, when they shifted to concrete paths, they gave a feed back that they experience undue pain n heels and knee joints.

1.11. Mud surfaces

Mud is a mixture of water and any combination of soil, silt, and clay, and usually forms after rainfall. Mud walking is an oldest method and the people are till fowling to walk on the mud as exercise. Regular walking will bring into a powerful mind and body workout. Normally we use to focus primarily on the fitness of our muscles and including the heart. Most of the people believe that the health and fitness are based on flexibility of the joints, relaxation of the nervous system, balanced breathing, and free circulation of the blood and lymphatic fluids to every organ and cell in the body. Any tension, tightening, binding or emotional blockage in the body inhibits free circulation and causes weakness in the organs and eventually disease.

1.12. Concrete surface

Concrete is primarily made up of cement crushed rock, and it's what most pavements and recreational parks are constructed from concrete. In concrete walking for lengthy periods can be rough on your feet, but when you're doing it on concrete, it delivers the most shock of any surface to a walker's legs. Walking on concrete flooring for long periods of time can cause sore feet, swollen legs, varicose veins and back pain. If you spend minimum two hours of time standing or walking on concrete flooring daily, shoes is compulsory for the walkers.

1.13. Road surface

Some walkers made a group for morning or evening walk and they formed a route that covered a target distance through roads with tarmac, mud, grass and the sides of the roads. They felt convenient and happy when they complete their daily target distance in target time while walking as a group. But they never complained any pains in the muscles or joints. It may also be an appropriate surface for walking with benefits.

Normally road is made with tar and small stones and it is totally different from other surfaces, because while walking on the road, we have to walk on the road and mud because of traffic, there may be up and downs on the surface. Sometimes we have to stand for few seconds to give way for the vehicle to cross us. Here we can get both hard and smooth surfaces. More than 70% we have to walk on hard surface in road walking and the consistency of walking may not that much better.

1.14. Innovations of the study

Because of their laziness, housewives have no time to prepare food at home. They seek for expedient and tasty stuff from hotels and fast food vendors. They eat food without knowing their names. Sedentary life style and eating foods of huge energy potential lead to mobility problems even at younger age. Eating more and doing nothing is the problem to the future wellbeing. These two, movement and eating good food would go a long way in deciding anybody's future health. If the connection is well understood, then mankind will have a better and healthy life.

The aim of this study was to provide three different surfaces to sensitize male population about the other physical activities which may contribute for their fitness avoiding monotony of activity thereby helping them to find peace and immunity, improved abilities and processing efficiency with their abilities and skills. The scholar tried mud surface to one experimental group, road surface to the next experimental group and a concrete surface to another experimental group. It would contribute to the society at large to have a healthy and active life if the experiments in the study are proved encouraging and the prescription of the best surface for walking would benefit the society at large.

Shunmugam and Sankaran (2015) conducted a study to find out the effect of walking on different surfaces on selected motor fitness and physiological variables among obese school boys. To achieve the purpose of this study, 30 obese students are randomly selected as subjects from different schools in Chennai, Tamilnadu, India. The selected participants were divided into three groups such as Group A underwent mud walking (n=10) and Group B underwent concrete walking (n=10) and Group C acted as control group (n=10). The training period was 60 minutes. Every week, training given only three alternative days for twelve weeks. Control group was not exposed to any specific training but they were participated in regular activities. The data on selected variables of motor fitness and physiological variable were collected by administering Cooper test and radial pulse rate test respectively. The pre and post tests data were collected on selected criterion variables prior and immediately after the training programme. It was concluded that, the experimental group had significantly improved in selected variables such as motor fitness and physiological variable and a significant difference in improvement was found among experimental and control groups in the selected criterion variables such as motor fitness and physiological variable. In another study the scholar said about the effect of walking on

different surfaces on selected physiological and biochemical variables among obese men. To achieve the purpose of this study, 30 obese men are randomly selected as subjects from the Chennai, Tamilnadu, India. The selected participants were divided into three groups such as Group A underwent mud walking (n=10) and Group B underwent concrete walking (n=10) and Group C acted as control group (n=10). The training period was 60 minutes. Every week, training given only three alternative days for twelve weeks. Control group was not exposed to any specific training but they were participated in regular activities. The data on selected variables of physiological and biochemical variable were collected by administering by radial pulse rate test and Lipid profile results respectively. The pre and post tests data were collected on selected criterion variables prior and immediately after the training programme. It was concluded that, the experimental group had significantly improved in selected variables such as physiological variable and biochemical variable and a significant difference in improvement was found among experimental and control groups in the selected criterion variables such as physiological variable and biochemical variable.

1.15. The independent variables

In today's nuclear family structure in Indian Society, the scene in the homes in every morning where the husband and wife go to office and the children to school is very pathetic. The scene would look like a battle field. After waking up in the morning, the mother begins her routine after a cup of coffee and by the time she sees off the children to school and the husband to the office, the morning time would have bade farewell to the homemaker woman. She might skip the breakfast and might have sent some packed food to the husband and the children for the lunch. They invite and honour the outcomes of these bad eating habits in the form of unwanted physical problems.

The independent variables chosen for this noble cause were mud walking, concrete walking and the road walking groups. Keeping walking as a constant, one group performed walking for a stipulated time on the mud surface, the other group walked on the concrete surface and the third group walked on the road surface for the whole of the experimental period for five days a week with diet restriction like the second group.

Sekhar et al. (2015) suggested that obesity could occur in any age, and generally increased with age. They argued that the aetiology of obesity was complex, and was one of multiple-causation. They declared that the first adverse effects of obesity to emerge in

population in transition were hypertension, hyperlipidaemia, glucose intolerance, coronary heart disease and the long term complications of Diabetes. Hence, in their opinion, it was necessary to detect the obesity at the early age and effectively correct the obesity during childhood and adolescence by advocating some life style changes. Hence they chose to study the following:

I. To determine the prevalence of Obesity in high school children
II. To study the some risk factors of Obesity

The present community based cross sectional study was conducted at urban area of Eluru during the period from July 2010 to October 2010 with the help of Community Medicine staff. A total of 258 high school children were selected from two different schools randomly and prior permission taken from concerned authorities. Importance of the study was explained to the school management and teachers. Pretested study questionnaire was filled and the height, weight, Body mass index and waist hip ratio were recorded in both sexes. Diagnosis of Obesity was based on Body mass index >25, BMI 18.5 to 25 taken as normal as per the WHO technical report guidelines. Results were critically analyzed and necessary statistical tests like proportions and chi square tests were applied.

Out of 258 students, 157 were boys and 101 girls. Prevalence of Obesity in the study population was 9.3%. Out of 24/258 (9.3%) obese individuals 16 girls and 10 boys. About 84% boys were taking junk food and 90% girls were consuming junk food. About 71.7% were spending 1 hour time on watching TV, 23.3% were spending > or = 2 hours time on watching TV and remaining 5% were not watching the TV in their houses. Obesity was significantly associated with female sex, junk food consumption, practice of exercise and watching TV ($P<0.01$).

The prevalence of Obesity was found to be higher as compared to other studies. We recommend that there is a need for checking simple body mass index and waist/hip ratio were useful to assess obesity in high school going children. So that simple life style modifications and nutritional advice to the students can be initiated as early as possible and also periodical school surveys must be taken up for early identification of obesity. Wide IEC programmes about healthy dietary practices for children must be advised.

1.16. Statement of the Problem

The purpose of the study was to critically analyze walking on different surfaces on selected motor fitness, physiological and biochemical variables among obese men.

1.17. Hypotheses

It has been scientifically accepted that any systematic training over a continuous period of time would lead to produce changes on athletic qualities. Based on this concept and research questions the following research hypotheses were formulated and it was tested at 0.05 level of confidence.

It was hypothesized that:

1. There would be significant improvement on the selected physiological variables of obese men due to effect of walking on different surfaces.

2. There would be significant improvement on the selected motor fitness variables of obese men due to effect of walking on different surfaces.

3. There would be significant improvement on the selected biochemical variables of obese men due to effect of walking on different surfaces.

1.18. Delimitations

1. To achieve the purpose of the study, 120 obese men were selected as subjects from Chennai, Tamilnadu, India at random.
2. The selected participants were randomly (simple random sampling) assigned to one of four groups of thirty (n=30) each, such as mud walking, concrete walking, road walking and control groups.
3. The age of the subjects ranged from 40 to 45 years.
4. The selected subjects were divided into four groups, namely mud walking, concrete walking, road walking groups and control group.
5. The following variables were selected as dependent variables for this study:

Physiological variables

Resting pulse rate

Vital capacity

Motor fitness

Cardiovascular fitness

Flexibility

Biochemical variables

Random blood sugar

Blood lipids

6. The standardized tests were used to collect relevant data on the selected dependent variables.

1.19. Limitations

1. The previous experience of the subjects in the field of sports and games, which might be influencing on the data collection, was not considered.
2. Psychological factors, food habits, rest period, life style and so forth could not be controlled.
3. The weather conditions such as atmospheric temperature, humidity and meteorological factors during testing period were also not considered.
4. Though the subjects were motivated verbally, no attempt was made to differentiate the motivation level during the period of testing.

1.20. Significance of the Study

1. The study will facilitate the evaluation of the contribution of Health and fitness towards the wellness of people.
2. The result of the study may help the coaches or trainers to formulate the training program with the combination of aerobic exercise to improve the standard of the subjects.
3. The new concept of walking on different surfaces will help the trainers to improve the wellness of people.

1.21. Definition of operational terms

1.21.1. Obesity

Obesity is a complex disorder involving an excessive amount of body fat. Obesity isn't just a cosmetic concern. It increases your risk of diseases and health problems, such as

heart disease, diabetes and high blood pressure. Being extremely obese means you are especially likely to have health problems related to your weight. The good news is that even modest weight loss can improve or prevent the health problems associated with obesity. Dietary changes, increased physical activity and behavior changes can help you lose weight. Prescription medications and weight-loss surgery are additional options for treating obesity. (*Obesity,* n.d.)

1.21.2. Walking

Walking (also known as ambulation) is one of the main gaits of locomotion among legged animals, and is typically slower than running and other gaits. Walking is defined by an 'inverted pendulum' gait in which the body vaults over the stiff limb or limbs with each step. This applies regardless of the number of limbs - even arthropods, with six, eight or more limbs, walk. (*Walking* n.d)

Walking is always an excellent exercise for weight control, but the low intensity offers no cardiovascular stimulus for those already in good condition. Walking at 6-7 kmph makes it difficult to elevate your heart rate above the minimum 70% MHR. For this reason, the running programme is generally recommended but if walking is your ‘thing’ here is two suggestions for increasing exercise intensity. (Vairamani and Sankaran 2011)

1.21.3. Resting pulse rate

The number of times a walker's heart beats per minute while at complete rest. Resting heart rate will decrease as the walker's heart becomes larger and stronger with training. A low resting heart rate is an indicator of fitness. (*Resting pulse rate n.d.)*

1.21.4. Vital capacity

Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inhalation. It is equal to the sum of inspiratory reserve volume, tidal volume, and expiratory reserve volume. A person's vital capacity can be measured by a wet or regular spirometer. In combination with other physiological measurements, the vital capacity can help make a diagnosis of underlying lung disease. Furthermore, the vital capacity is used to determine the severity of respiratory muscle involvement in neuromuscular disease, and can guide treatment decisions in Guillain-Barré syndrome and myasthenic crisis. A normal adult has a vital capacity between 3 and 5 litres.

A human's vital capacity depends on age, sex, height, mass, and ethnicity. (*Vital capacity*, n.d)

1.21.5. Cardiovascular fitness

Cardiovascular fitness is the ability of the cardiovascular system to efficiently supply oxygen to working muscles. Cardiovascular fitness facilitates prevention of various diseases such as unnecessary blood clotting, congestive heart failure, stroke and peripheral artery disease among others. Cardiovascular fitness can be increased through regular exercises and eating of a balanced diet. Cardiovascular fitness refers to the ability of your heart, lungs and organs to consume, transport and utilize oxygen. The maximum volume of oxygen your body can consume and use is yourVO2 Max. When you exercise regularly, you can increase your cardiovascular fitness as your heart becomes more efficient at pumping blood and oxygen to the body, and the body becomes more efficient at using that oxygen. (*Cardiovascular fitness*, n.d)

1.21.6. Flexibility

The ability is the ability to move the various parts of the body at the desired time in the preferred direction without difficulty. (Vairamani and Sankaran 2013)

Flexibility is defined as the range of motion of your joints or the ability of your joints to move freely. It also refers to the mobility of your muscles, which allows for more movement around the joints. Range of motion is the distance and direction your joints can move, while mobility is the ability to move without restriction. Flexibility is important in fitness because it allows for better performance when playing sports or exercising and in your day-to-day activities, such as bending, walking and lifting. In this lesson, you will learn how stretching and certain types of exercises can help improve flexibility. (*Flexibility*, n.d)

1.21.7. Blood sugar

Blood sugar is the main sugar that the body makes from the food in the diet. Glucose is carried through the bloodstream to provide energy to all cells in the body. Cells cannot use glucose without the help of insulin. Glucose is a simple sugar (a monosaccharide). The body produces it from protein, fat and, in largest part, carbohydrate. Ingested glucose is absorbed directly into the blood from the intestine and results in a rapid increase in blood glucose. Glucose is also known as dextrose. (*Blood sugar*, n.d)

1.21.8. Blood lipids

Blood lipids or blood fats are lipids in the blood, either free or bound to other molecules. They are mostly transported in a protein capsule, and the density of the lipids and type of protein determines the fate of the particle and its influence on metabolism. The concentration of blood lipids depends on intake and excretion from the intestine, and uptake and secretion from cells. Blood lipids are mainly fatty acids and cholesterol. Hyperlipidemia is the presence of elevated or abnormal levels of lipids and/or lipoproteins in the blood, and is a major risk factor for cardiovascular disease.

The biologically important lipids are the fatty acids and their derivates, the neutral fats (triglycerides), the phospholipids and related compounds, and the sterols. The triglycerides are made up of three fatty acids bound to glycerol. Naturally occurring fatty acids contain an even number of carbon atoms. They may be saturated or unsaturated. The phospholipids are constituents of cell membranes. The sterols include the various steroid hormones and cholesterol. A diverse group of organic molecules that contain long hydrocarbon chains or rings and are hydrophobic

Blood lipids are another word for "fats." Lipids can be more formally defined as substances such as a fat, oil or wax that dissolves in alcohol but not in water. Lipids contain carbon, hydrogen and oxygen but have far less oxygen proportionally than carbohydrates. Lipids are an important part of living cells. Together with carbohydrates and proteins, lipids are the main constituents of plant and animal cells. Cholesterol and triglycerides are lipids. Lipids are easily stored in the body. They serve as a source of fuel and are an important constituent of the structure of cells. Lipids include fatty acids, neutral fats, waxes and steroids (like cortisone). Compound lipids (lipids complexed with another type of chemical compound) comprise the lipoproteins, glycolipids and phospholipids. (*Blood lipids*, n.d)

1.21.9. Lipoproteins

The chylomicrons and their remnants constitute a transport system for ingested exogenous lipids. There is also an endogenous system made up of VLDL, intermediate-density lipoproteins (IDL), low-density lipoproteins (LDL) and high-density lipoproteins

(HDL), which transports triglycerides and cholesterol throughout the body. (William. F et al (2003)

Lipoproteins are complexes of lipid and protein, the way lipids travel in the blood. Cholesterol, a building block of the outer layer of cells (cell membranes), is transported through the blood in the form of water-soluble carrier molecules known as lipoproteins. The lipoprotein particle is composed of an outer shell of phospholipid, which renders the particle soluble in water; a core of fats called lipid, including cholesterol and a surface apoprotein molecule that allows tissues to recognize and take up the particle. These lipoproteins are characterized by their density: high density lipoprotein (HDL), low density lipoprotein (LDL), very low density lipoprotein (VLDL). The first stages of cholesterol build up in the blood vessels (atherosclerosis) occur when LDL particles circulating in the blood penetrate through the inner lining of blood vessels and become trapped in the artery wall. Eventual build up of LDL, fat-filled cells, cells of inflammation, and blood clotting can block the normal blood flow in the coronary, carotid, cerebral, or other arteries including those in the legs. This type of blockage causes clinical syndromes such as heart attack and stroke. Blockage of arteries in the legs is call peripheral arterial disease (PAD). PAD is a factor in amputations of toes, feet, or legs. (*Lipoproteins,* n.d)

1.22. Organization of the thesis

This section gives a clear picture of how the remaining section of this thesis is organized. In Chapter II, literature reviews on topics relating to the thesis are presented. The areas that are directly related to this thesis have been covered in detail. It also focuses on describing the methods used in assessing the motor fitness variables, physiological variables and biochemical variables. Chapter III presents the methods involved in the selection of subjects, organizing the testing procedures, calibration of measuring instruments, the schedule of walking done on various surfaces prescribed to the subjects. Chapter IV demonstrates the methods of analyzing the data statistically, interpretation of the data and discussing the cause and effect of dependent variable. Chapter V summarizes the whole of the work and conclusions are drawn based on the findings of the study. Also some recommendations are made on the basis of the findings of the study and the scope for future work on the same area with different dependant and independent variables.

Chapter II

REVIEW OF RELATED LITERATURE

Review of related literature is important to have better understanding of the problem. The researcher attempted to review numerous relevant studies. Based on the purpose of the study, the reviews have been classified into five areas namely a) Walking b) Obesity c) Motor fitness, d) Physiological and e) Biochemical variables, and they are presented in this chapter. These reviews might be helpful in interpreting the results that were obtained during course of the current study. The review was confined to the libraries of Dr. M.G.R. Educational and Research Institute University, Chennai, YMCA College of Physical Education, Chennai, Tamil Nadu Physical Education and Sports University, Chennai, Alagappa University, Karaikudi and Pondicherry Central University and through the Internet (web sources). The scholar had a chance of reading the printed versions of completed researches through the journals and compilations. The literature in any field forms the foundation upon which all future work will be built. If we do not succeed to build upon the basis of knowledge provided by the review of literature, the scholar might miss some vital works already done on the same area of his area of research.

2.1. Studies on Obesity

Albuquerque et al. (2015) had identified that obesity was a complex multi-factorial and heterogeneous condition with an important genetic component. Recently, major advances in obesity research emerged concerning the molecular mechanisms contributing to the obese condition. This review outlined several studies and data concerning the genetics and other important factors in the susceptibility risk to develop obesity. Based in the genetic aetiology three main categories of obesity are considered: monogenic, syndromic, and common obesity. For the monogenic forms of obesity, the gene causing the phenotype was clearly identified, whereas for the common obesity the *loci* architecture underlying the phenotype is still being characterized. Given that, in this review they focused mainly in this obesity form, reviewing *loci* found until now by genome-wide association studies related with the susceptibility risk to develop obesity. Moreover, they also detailed the obesity-related *loci* identified in children and in different ethnic groups,

trying to highlight the complexity of the genetics underlying the common obese phenotype. Importantly, they also focused in the evolutionary hypotheses that had been proposed trying to explain how natural selection favored the spread of genes that increased the risk for an obese phenotype and how this predisposition to obesity evolved. Other factors were important in the obesity condition, and thus, they also discussed the epigenetic mechanisms involved in the susceptibility and development of obesity. Covering all these topics they expected to provide a complete and recent perspective about the underlying mechanisms involved in the development and origin of obesity. Only with a full understanding of the factors and mechanisms contributing to obesity, it would be possible to provide and allow the development of new therapeutic approaches to this condition.

Sarma et al. (2014) felt that although physical activity had been considered as an important modifiable risk factor for obesity, the empirical evidence on the relationship between physical activity and obesity had been mixed. Observational studies in the public health literature failed to account for time-invariant unobserved heterogeneity and dynamics of weight, leading to biased estimation of the effect of physical activity on obesity. To overcome this limitation, they proposed dynamic fixed-effects models to account for unobserved heterogeneity bias and the dynamics of obesity. They had used nationally representative longitudinal data on the cohort of adults aged 18-50 years in 1994/95 from Canada's National Population Health Survey and followed them over 16 years. Obesity was measured by BMI (body mass index). After controlling for a wide range of socio-economic factors, the impact of four alternative measures of leisure-time physical activity (LTPA) and work-related physical activity (WRPA) were analyzed. The results showed that each measure of LTPA exerted a negative effect on BMI and the effects are larger for females. Their key results showed that participation in LTPA exceeding 1.5kcal/kg per day (i.e., at least 30min of walking) reduceed BMI by about 0.11-0.14 points in males and 0.20 points in females relative to physically inactive counterparts. Compared to those who were inactive at workplace, being able to stand or walk at work was associated with a reduction in BMI in the range of 0.16-0.19 points in males and 0.24-0.28 points in females. Lifting loads at workplace was associated with a reduction in BMI by 0.2-0.3 points in males and 0.3-0.4 points in females relative to those who were reported sedentary. Policies aimed at promotion of LTPA combined with WRPA like walking or climbing stairs daily would help reduce adult obesity risks.

Swift et al. (2014) explored the role of physical activity (PA) and exercise training (ET) in the prevention of weight gain, initial weight loss, weight maintenance, and the obesity paradox. In particular, they focused the discussion on the expected initial weight loss from different ET programs, and explored intensity/volume relationships. Based on the present literature, unless the overall volume of aerobic ET was very high, clinically significant weight loss was unlikely to occur. Also, ET also had an important role in weight regain after initial weight loss. Overall, aerobic ET programs consistent with public health recommendations might promote up to modest weight loss (~2 kg), however the weight loss on an individual level was highly heterogeneous. Clinicians should educate their patients on reasonable expectations of weight loss based on their physical activity program and emphasize that numerous health benefits occur from PA programs in the absence of weight loss.

Inge et al. (2013), hypothesized that adolescent obesity would be associated with greater risks of adverse health in severely obese adults. Before weight loss surgery, adult participants in the Longitudinal Assessment of Bariatric Surgery-2 underwent detailed anthropometric and comorbidity assessment. Weight status at age 18 was retrospectively determined. Participants who were 80 percent certain of recalled height and weight at age 18 (1502 of 2308) were included. Log binomial regression was used to evaluate whether weight status at age 18 was independently associated with risk of comorbid conditions at time of surgery controlling for potential confounders. Median age and adult body mass index (BMI) were 47 years and 46, respectively. At age 18, 42% of subjects were healthy weight, 29 percent overweight, 16% class 1 obese, and 13% class ≥2 obese. Compared with healthy weight at age 18, class ≥2 obesity at age 18 independently increased the risk of lower-extremity venous edema with skin manifestations by 435 severe walking limitation by 321abnormal kidney function by 302 polycystic ovary syndrome by 74 asthma by 48diabetes by 42obstructive sleep apnea by 25% and hypertension (by varying degrees based on age and gender). Severe obesity at age 18 was independently associated with increased risk of several comorbid conditions in adults undergoing bariatric surgery.

Heden et al. (2013) discussed that **t**he incretin hormones glucagon-like peptide-1 (GLP-1) and glucose-dependent insulinotropic polypeptide (GIP) help regulate postprandial triacylglycerol (TAG) and insulin concentrations, but the effects of acute

aerobic exercise on GLP-1 or GIP responses are unclear. The purpose of this study was to determine whether reductions in postprandial TAG and insulin with exercise are associated with GLP-1 and GIP responses. Thirteen normal-weight (NW) and 13 obese (Ob) individuals participated in two, 4-d trials in random order including an exercise (EX) and a no exercise (NoEX) trial. Diet was controlled during both trials. The EX trial consisted of 1 h of treadmill walking during the evening of day 3 of the trial, 12 h before a 4-h mixed meal test on day 4, during which frequent blood samples were collected to assess postprandial lipemia, glycemia, insulin, C-peptide, GIP, and GLP-1 responses. Insulin secretion was estimated using the insulinogenic index, and insulin clearance was estimated using the ratio of insulin to C-peptide.Postprandial TAG were 29% lower after EX in Ob individuals but were not significantly altered in NW individuals. The drop in postprandial HDL cholesterol was attenuated with EX in Ob individuals Insulin responses were 14% lower after EX in Ob individuals and this was associated with reduced insulin secretion with no change in insulin clearance Glucose, C-peptide, GIP, and GLP-1 were not different between trials.A 1-h bout of moderate-intensity aerobic exercise the night before a mixed meal attenuates TAG and insulin responses in Ob but not NW individuals, an effect not associated with altered GLP-1 or GIP responses.

Ekman MJ et al. (2013) found that weight loss and physical activity had shown favorable effects on risks associated with obesity. It was therefore of interest to evaluate exercise capacity and related co-morbidities in obese patients. They presented data from obese subjects evaluated by the 6-minute walk test (6MWT) before and after a 7.3 month weight reduction program.251 subjects completed the test at baseline (BMI 40.6 [36.9-44.6] kg/m(2)) and 129 (51.4%) repeated the test after intervention (BMI 35.6 [31.2-38.5] kg/m(2)). The six minute walking distance (6MWD) at baseline (535 [480-580] m) and at follow up (599 [522-640] m) correlated to several cardiovascular risk markers. Age, weight, height, resting heart rate, smoking status, fP-glucose and use of β-blockers explained 43 % of the variance in predicted 6MWD at baseline. The effect of smoking status, fP-glucose, β-blockers, and resting heart rate lost significance at follow up. Presence of diabetes and the metabolic syndrome had a negative influence on 6MWD but did not affect the impact of intervention based on percentage increase in walking distance. Gender had no impact on 6MWD. Reported pain during the test was common but decreased after intervention the 6MWT may be used to evaluate intervention success beyond kilogram weight loss in obese subjects. They had presented formulas to predict 6MWD and

the effect of weight loss on walking distance in clinical practice. Pain was a common problem which had to be considered when giving advice on exercise as a part of weight loss intervention.

2.1. Studies on walking

Murtagh et al. (2015) studied the effect of walking on risk factors for cardiovascular disease. Four electronic databases and reference lists were searched (Jan 1971–June 2012). Two authors identified randomized control trials of interventions ≥ 4 weeks in duration that included at least one group with walking as the only treatment and a no-exercise comparator group. Participants were inactive at baseline. Pooled results were reported as weighted mean treatment effects and 95% confidence intervals using a random effects model. Results 32 articles reported the effects of walking interventions on cardiovascular disease risk factors. Walking increased aerobic capacity (3.04 mL/kg/min, 95% CI 2.48 to 3.60) and reduced systolic (− 3.58 mm Hg, 95% CI − 5.19 to − 1.97) and diastolic (− 1.54 mm Hg, 95% CI − 2.83 to − 0.26) blood pressure, waist circumference (− 1.51 cm, 95% CI − 2.34 to − 0.68), weight (− 1.37 kg, 95% CI − 1.75 to − 1.00), percentage body fat (− 1.22%, 95% CI − 1.70 to − 0.73) and body mass index (− 0.53 kg/m^2, 95% CI − 0.72 to − 0.35) but failed to alter blood lipids. Conclusions, walking interventions improve many risk factors for cardiovascular disease. This underscores the central role of walking in physical activity for health promotion.

Shepherd et al. (2015) conducted a randomized, double blind, placebo-controlled cross-over study, 48 participants with T2DM supplemented their diet for four days with either nitrate rich beetroot juice (70 ml/day, 6.43 mmol nitrate/day) or nitrate depleted beetroot juice as placebo (70 ml/day, 0.07 mmol nitrate/day). After each intervention period, resting plasma nitrate and nitrite concentrations were measured subsequent to participants completing moderate-paced walking. Pulmonary gas exchange was measured to assess the O_2 cost of walking. Following a rest period, participants performed the six-minute walk test (6MWT). Results Relative to placebo, beetroot juice resulted in a significant increase in plasma nitrate (placebo: 57±66 *vs.*beetroot: 319±110 μM; P <0.001) and plasma nitrite concentration (placebo: 680±256 *vs.* beetroot: 1065±607 nM; P <0.001). There were no differences between placebo juice *vs.* beetroot juice for the O_2cost of walking (946±221 *vs.* 939±223 ml.min^{-1}, respectively; P =0.59), and distance covered in the 6MWT (550±83 *vs.* 554±90 m, respectively; P =0.17). Nitrate supplementation did not

affect the O_2 cost of moderate-paced walking or improve performance in the 6MWT. These findings indicate that dietary nitrate supplementation does not modulate the response to exercise in individuals with T2DM.

Cadenas-Sánchez et al. (2015) examined spatiotemporal characteristics and joint angles during forward and backward walking in water at low and high stride frequency. Eight healthy adults (22.1 ± 1.1 years) walked forward and backward underwater at low (50 pulses) and high frequency (80 pulses) at the xiphoid process level with arms crossed at the chest. The main differences observed were that the participants presented a greater speed (0.58 vs. 0.85 m/s) and more asymmetry of the step length (1.24 vs. 1.48) at high frequency whilst the stride and step length (0.84 vs. 0.7 m and 0.43 vs. 0.35 m, respectively) were lower compared to low frequency ($P < 0.05$). Support phase duration was higher at forward walking than backward walking (61.2 vs. 59.0%). At initial contact, we showed that during forward walking, the ankle and hip presented more flexion than during backward walking (ankle: 84.0 vs. 91.8º and hip: 22.8 vs. 8.0º; $P < 0.001$). At final stance, the knee and hip were more flexed at low frequency than at high frequency (knee: 150.0 vs. 157.0º and hip: -12.2 vs. -14.5º; $P < 0.001$). The knee angle showed more flexion at forward walking (134.0º) than backward walking (173.1º) ($P < 0.001$). In conclusion, these results show how forward and backward walking in water at different frequencies differ and contribute to a better understanding of this activity in training and rehabilitation.

Duvivier et al. (2013) hypothesized that a daily bout of exercise could not compensate the negative effects of inactivity during the rest of the day on insulin sensitivity and plasma lipids. Eighteen healthy subjects, age 21±2 year, BMI 22.6±2.6 kgm(-2) followed randomly three physical activity regimes for four days. Participants were instructed to sit 14 hr/day (sitting regime); to sit 13 hr/day and to substitute 1 hr of sitting with vigorous exercise 1 hr (exercise regime); to substitute 6 hrs sitting with 4 hr walking and 2 hr standing (minimal intensity physical activity (PA) regime). The sitting and exercise regime had comparable numbers of sitting hours; compared to the exercise regime, the minimal intensity PA regime had a higher estimated daily energy expenditure (238kcal/day) [corrected]. PA was assessed continuously by an activity monitor (ActivPAL) and a diary. Measurements of insulin sensitivity (oral glucose tolerance test, OGTT) and plasma lipids were performed in the fasting state, the morning after the 4 days of each regime. In the sitting regime, daily energy expenditure was about 500 kcal lower

than in both other regimes. Area under the curve for insulin during OGTT was significantly lower after the minimal intensity PA regime compared to both sitting and exercise regimes 6727.3±4329.4 vs 7752.0±3014.4 and 8320.4±5383.7 mU•min/ml, respectively. Triglycerides, non-HDL cholesterol and apolipoprotein B plasma levels improved significantly in the minimal intensity PA regime compared to sitting and showed non-significant trends for improvement compared to exercise.

Masuki et al. (2015) fond that no long-term exercise training regimen with high adherence and effectiveness in middle-aged and older people was broadly available in the field. They assessed the adherence to, and effects of, our long-term training program comprising an interval walking training (IWT) and an information technology network system and the factors affecting adherence. Middle-aged and older men and women [n = 696, aged 65 ± 7(SD) yr] underwent IWT. The subjects were instructed to repeat five or more sets of fast and slow walking for 3 min each at ≥70 and 40% peak aerobic capacity for walking ($V\square O_{2peak}$), respectively, per day ≥4 days/wk for 22 mo. Adherence was assessed as training days accomplished relative to the target of 4 days/wk over 22 mo. The effects on the $V\square O_{2peak}$ and lifestyle-related disease score were evaluated every 6 mo. The independent factors affecting adherence were assessed by multiple-regression analysis after adjustment for baseline physical characteristics and other possible covariates, including vasopressin V1a receptor polymorphisms. The adherence over 22 mo averaged 70% and was highly correlated with a 13% reduction in the lifestyle-related disease score (R^2 = 0.94, P = 0.006) and with a 12% increase in $V\square O_{2peak}$ (R^2 = 0.94, P = 0.006). The major determinant of higher adherence was lower baseline body mass index (BMI) (P < 0.0001) and male sex (P < 0.0001). For men, in addition to BMI, nonsmokers (P= 0.031) and V1a receptor polymorphisms (P = 0.033) were independent determinants of higher adherence. Thus the long-term IWT program is an effective regimen. Moreover, baseline BMI and sex for all subjects, and smoking and V1a receptor polymorphisms for men, were associated with adherence.

Colley et al. (2010) felt that walking was commonly recommended to help with weight management. We measured total energy expenditure (TEE) and its components to quantify the impact of increasing exercise-induced energy expenditure (ExEE) on other

components of TEE. Thirteen obese women underwent an 8-week walking group intervention. TEE was quantified using doubly labeled water, ExEE was quantified using heart rate monitors, daily movement was assessed by accelerometer and resting metabolic rate was measured using indirect calorimeter. Four of the 13 participants achieved the target of 1500kcalwk(-1) of ExEE and all achieved 1000kcalwk(-1). The average ExEE achieved by the group across the 8 weeks was 1434+/-237kcalwk(-1). Vigorous physical activity, as assessed by accelerometer, increased during the intervention by an average of 30min per day. Non-exercise activity thermo genesis (NEAT) decreased, on average, by 175kcald(-1) (-22%) from baseline to the intervention and baseline fitness was correlated with change in NEAT. potential alterations in non-exercise activity should be considered when exercise is prescribed. The provision of appropriate education on how to self-monitor daily activity levels may improve intervention outcomes in groups who are new to exercise. Strategies to sustain incidental and light physical activity should be offered to help empower individuals as they develop and maintain healthy and long-lasting lifestyle habits.

2.2 Studies on motor fitness

Balemans AC et al. (2015) conducted a study and 24 children with bilateral and 22 with unilateral spastic CP, aged 7–13, all walking, participated in this study. Physical fitness was measured by aerobic capacity (VO_2peak), anaerobic threshold, and anaerobic capacity and, isometric and functional muscle strength. Walking-related PAL was measured using an ankle-worn StepWatch™ activity monitor for 1 week. Fatigue was determined with the PedsQL multidimensional fatigue scale. Longitudinal associations were analyzed by random coefficient regression analysis ($p<0.05$). Results n children with bilateral CP, all fitness parameters showed a positive, significant association with walking-related PAL, whereas no associations between physical fitness and walking-related PAL were seen in children with unilateral CP. No clinically relevant association between physical fitness and fatigue was found. Although random coefficient regression analysis can be used to investigate longitudinal associations between parameters, a causal relationship cannot be determined. The actual direction of the relation between physical fitness and walking-related PAL therefore remained inconclusive. Children with bilateral spastic CP might benefit from an improved physical fitness to increase their PAL or vice versa, while this was not the case in children with unilateral CP. There seemed no relationship between physical fitness and self-reported fatigue in all children with CP.

Interventions aimed at improving PAL might be differently targeted in children with either bilateral or unilateral CP.

Stewart AD et al. (2014) found that supervised physical activity (PA) interventions had demonstrated improvements in morphological and health parameters, whereas community walking programmes have not. The present study piloted a self-guided programme for promoting PA and reducing sedentary behaviour in overweight individuals and measured its effect on a range of health outcomes. Six male and 16 female sedentary adults aged 48.5 ± 5.5 years with body mass index (BMI) 33.4 ± 6.3 kg m(-2) were assessed for anthropometric variables, blood pressure, functional capacity, well-being and fatigue. After an exercise consultation, participants pursued their own activity and monitored PA points weekly. At baseline, mid-point and 12 weeks, eight participants wore activity monitors, and all participants undertook a 5-day food diary to monitor dietary intake. In 17 completers, mass, BMI, sit-to-stand, physical and general fatigue had improved by 6 weeks. By 12 weeks, waist, sagittal abdominal diameter (SAD), diastolic blood pressure, well-being and most fatigue dimensions had also improved. Throughout the intervention, PA was stable, energy intake and lying time decreased and standing time increased; thus, changes in both energy intake and expenditure explain the health-related outcomes. Observed changes in function, fatigue and quality of life are consistent with visceral fat loss and can occur at levels of weight loss which may not be considered clinically significant.

Vameghi et al. (2013) examined the effect of age, sex and obesity on Fundamental Motor Skills (FMS) in 4 to 6 years-old children. Methodology: A total of 400 preschool children (200 boys and 200 girls) between the ages of 4 to 6 years old participated in this research. Subjects were selected through multi-stage cluster random sampling. Fundamental motor skills (FMS) were assessed with using the OSU-SIGMA scale. Body mass index (BMI) was directly measured from height(m)(2)/weight(kg) for each child and based on CDC growth charts, normal weight, overweight and obesity were defined. Results: The results showed that age and sex variables were a significant effect on walking and running skills, but BMI was not significant ($P>0.05$). Also, these variables had a significant effect on jumping, skipping, hopping and ladder climbing. In both ages, boys in jumping and ladder climbing skills were better than girls, but the girls were better in skipping and hopping skills ($P<0.05$). Moreover, the results

showed that age and BMI variables have a significant effect on stair climbing skill, but sex was not significant (P>0.05). For object control skills, the results showed that age and sex variables were a significant effect on catching and throwing skills, but BMI was not significant (P>0.05). Finally, the age, sex and BMI variables were a significant effect on kicking and sticking skills. Conclusion: This research demonstrated that boys performed better than girls, and both overweight and obese children had lower performance than normal children.

2.2. Studies on surfaces

Today, in the U.S., 145 million men and women walk for fitness and health. Doctors are prescribing walking as "a wonder drug" with a wide range of benefits. State governments are spending millions of dollars to develop pleasant places to walk to encourage people to get off the couch. Four-thousand years ago in the mountains of China, a group of monks also realized the value of walking. Over time, they evolved the simple act of walking called *circle walking* into a complete physical, mental and neurological training with powerful rejuvenative effects. To this day, it is said that *circle walking* can turn back the clock. Mud walking is a Westernized version of this ancient exercise. It will transform your daily walking routine into a powerful mind-body workout in the same amount of time you spend doing "ordinary" walking. Mud walking is a Westernized version of a 4000-year-old Chinese fitness training called circle walking. Circle walking was prized for its ability to develop strength, flexibility, agility, and vitality. (*Mud walking* n.d)

Farhang et al. (2015) felt that shock absorbance, or force reduction, was the most significant parameter in sport surfaces which had been used as an injury prevention criterion. Many sport federations like the International Association of Athletics Federations, the International Federation of Association Football and the International Hockey Federation had arranged force reduction tests for sport surfaces which were performed by an apparatus called the Artificial Athlete Berlin. As this apparatus had been designed for simulating a normal subject at usual conditions, some major details were neglected. In their article, a finite element model, which included the human lower limb and a standard sport surface, was developed and was capable of extracting force reduction parameters in various sport conditions. The viscoelastic behaviour of the sport surface was extracted by compression stress-relaxation tests with various strain rates to import into the

finite element model. To calculate the shock absorbance of the sport surface, the contact pressure versus time curves were plotted for the top and bottom layers of the sport surface. The difference between peak values of curves was extracted as the sport surface shock absorbance ability. To validate the proposed model, a finite element model which included the Artificial Athlete Berlin apparatus was simulated. The results present an excellent correlation between the proposed and the Artificial Athlete Berlin apparatus models. Also, the shock absorption value obtained by the proposed model was close to the average value reported by the ASTM F2772 standard which the sport surface meets.

Joshi and Srinivasan (2015) explained that understanding how humans walk on a surface that could move might provide insights into, for instance, whether walking humans prioritized energy use or stability. Here, motivated by the famous human-driven oscillations observed in the London Millennium Bridge, they introduced a minimal mathematical model of a biped, walking on a platform (bridge or treadmill) capable of lateral movement. This biped model consisted of a point-mass upper body with legs that can exert force and perform mechanical work on the upper body. Using numerical optimization, they obtained energy-optimal walking motions for this biped, deriving the periodic body and platform motions that minimized a simple metabolic energy cost. When the platform had an externally imposed sinusoidal displacement of appropriate frequency and amplitude, they predicted that body motion entrained to platform motion consumed less energy than walking on a fixed surface. When the platform had finite inertia, a mass-spring-damper with similar parameters to the Millennium Bridge, they showed that the optimal biped walking motion sustained a large lateral platform oscillation when sufficiently many people walk on the bridge. Here, the biped model reduced walking metabolic cost by storing and recovering energy from the platform, demonstrating energy benefits for two features observed for walking on the Millennium Bridge: crowd synchrony and large lateral oscillations.

Hawley JA (2008) contemplated that concrete was among the least forgiving of walking surfaces, causing significant shock to the lower-body joints. "Lore of Running" noted that the risk of injury, particularly to women who run, increased on a concrete surface. On the other hand, concrete was often a relatively smooth and regular surface. Generally, the drawbacks of walking on a cement-paved surface outweighed the pros over time, and should avoid training on concrete whenever possible.

Marchesi et al. (2014) explained that in recent years, the pandemic explosion of obesity had led to the definition of a pre-eminent therapeutic role for bariatric surgery, confining physical activity to a success parameter of surgery rather than a primary prevention measure. The aim of their study was to evaluate the role for aerobic physical activity (road running) in strengthening the metabolic and psychosocial effects of bariatric surgery. Ten patients who underwent gastric bypass for morbid obesity were submitted to an intensive program of road running training, aimed at completing a 10.5-km competition in September 2013. Inclusion criteria included age (<50), BMI (<35), suitability for sport activity, and good compliance. A cohort of 10 patients excluded for logistical issues were enrolled as a control group. During the training period, patients were submitted to biometrical, sport performance, cardiopulmonary, metabolic, and psychiatric evaluations. Protocol adherence was 70 %; no physical injury was registered among participants. More than weight loss (BMI 29.3 to 27.1), the runners experienced a redistribution of body mass with significant differences in fat percentage and waist/hip ratio. Participants had a significant running performance improvement and, differently from the controls, a significant amelioration of echocardiographic and cardiopulmonary parameters, predicting a reduction in cardiovascular risk. Psychiatric evaluation underlined a tendency to a reduction in anxiety, depression, and general psychopathology symptoms. Road running seemed to have an important supporting role in boosting bariatric surgery results. The utilization of monitored and regulated training programs represented a fundamental prerequisite to achieving satisfactory results and patient compliance.

Chen and lin (2014) pondered walking suitability of city road was an important index to evaluate city road,while evaluating walking suitability mainly depended on analyzing walking characteristics of pedestrian. Walking was the primary trip model in Lhasa and more over Ritual walk took a high percentage in walking. This paper studied with the Linkuo ritual walk path which was the longest and closest with traffic in Lhasa centre city. Through the survey and the analysis of the ritual crowd by age,walk speed and the custom of cross the street, they could get some unique characteristics of the ritual crowd in Lhasa. After that, they had evaluated the Linkuo ritual walk path and give some advised for ritual walk traffic in Lhasa from micro view, middle view and macro view.

2.3. Motor fitness variable

2.5.1 Cardio vascular endurance

Schulz et al. (2015) evaluated the effectiveness of the walk your heart to health (*WYHH*) intervention, one component of the multilevel Community Approaches to Cardiovascular Health: Pathways to Heart Health (CATCH: PATH) intervention designed to promote physical activity and reduce cardiovascular risk among non-Hispanic Black and Hispanic residents of Detroit, Michigan. The study was designed and implemented using a community-based participatory research approach that actively engaged community residents, health service providers and academic researchers. It was implemented between 2009 and 2012. WYHH was a 32-week community health promoter–facilitated walking group intervention. Groups met three times per week at community-based or faith-based organizations, and walked for 45 to 90 minutes (increasing over time). The study used a cluster randomized control design to evaluate effectiveness of WYHH, with participants randomized into intervention or lagged intervention (control) groups. Psychosocial, clinical, and anthropometric data were collected at baseline, 8, and 32 weeks, and pedometer step data tracked using up loadable piezoelectric pedometers. Participants in the intervention group increased steps significantly more during the initial 8-week intervention period, compared with the control group ($\beta = 2004.5$, $p = .000$). Increases in physical activity were associated with reductions in systolic blood pressure, fasting blood glucose, total cholesterol, and waist circumference and body mass index at 8 weeks, and maintained at 32 weeks. The WYHH community health promoter–facilitated walking group intervention was associated with significant reductions in multiple indicators of cardiovascular risk among predominantly Hispanic and non-Hispanic Black participants in a low-to-moderate income urban community. Such interventions can contribute to reductions in racial, ethnic, and socioeconomic inequities in cardiovascular mortality.

Murtagh et al. (2015) studied the effect of walking on risk factors for cardiovascular disease. Four electronic databases and reference lists were searched (Jan 1971–June 2012). Two authors identified randomised control trials of interventions ≥ 4 weeks in duration that included at least one group with walking as the only treatment and a no-exercise comparator group. Participants were inactive at baseline. Pooled results were reported as weighted mean treatment effects and 95% confidence intervals using a random effects model. Results 32 articles reported the effects of walking interventions on cardiovascular disease risk factors. Walking increased aerobic capacity (3.04 mL/kg/min,

95% CI 2.48 to 3.60) and reduced systolic (− 3.58 mm Hg, 95% CI − 5.19 to − 1.97) and diastolic (− 1.54 mm Hg, 95% CI − 2.83 to − 0.26) blood pressure, waist circumference (− 1.51 cm, 95% CI − 2.34 to − 0.68), weight (− 1.37 kg, 95% CI − 1.75 to − 1.00), percentage body fat (− 1.22%, 95% CI − 1.70 to − 0.73) and body mass index (− 0.53 kg/m^2, 95% CI − 0.72 to − 0.35) but failed to alter blood lipids. Conclusions, walking interventions improve many risk factors for cardiovascular disease. This underscores the central role of walking in physical activity for health promotion.

Bergstrom et al. (2014) made twenty-one men to complete the randomized, double-blinded, placebo-controlled, crossover study to examine acute responses to a thermogenic nutritional supplement. Each testing session included: 1) 30 min resting, followed by placebo or thermogenic nutritional supplementation; 2) 50 min post-supplementation resting; 3) 60 min walking; and 4) 50 min post-exercise recovery. Gas exchange variables and heart rate (HR) were recorded during each phase. Blood pressure was recorded during all phases except exercise. Ratings of perceived exertion (RPE) were recorded only during exercise. There were no significant differences for any of the measures between the supplement and placebo during the initial resting, or post-supplementation phases. During exercise, energy expenditure (EE) (placebo = 18.98-19.06 KJ·min and supplement = 19.44-19.82 KJ·min) and O2 (placebo = 11.27-11.35 ml·kg·min; supplement = 11.64-11.82 ml·kg·min) were greater for the supplement than placebo. There were no differences in RER, HR, or RPE between the supplement and placebo during exercise. Post-exercise, only O2 (placebo = 3.53-3.63 ml·kg·min; supplement = 3.71-3.84 ml·kg·min) was greater for the supplement than placebo, but there were no differences in EE, RER, HR, or blood pressure. These findings suggested that the specific blend of ingredients in the thermogenic nutritional supplement, when combined with exercise, increased the metabolic rate with minimal changes in cardiovascular function and no effect on RPE.

Mackay Lyons et al. (2013) felt that body-weight-supported treadmill training (BWSTT) to train both fitness and ambulation had not been investigated. To compare the effectiveness of BWSTT to dose-equivalent usual care (UC) in improving cardiovascular fitness and walking early after stroke. Participants were randomly assigned to 1 of 2 interventions: BWSTT + UC or UC. All individuals participated in 60-minute physiotherapy sessions 5 times weekly as inpatients for 6 weeks and 3 times weekly as

outpatients for another 6 weeks. Baseline, post training, 6-, and 12-month follow-up outcome measures were as follows: primary, fitness (peak oxygen consumption, VO2peak) and walking ability (6-Minute Walk Test [6MWT] and 10-m walk); secondary, Berg Balance Scale (BBS) and motor impairment (Chedoke-McMaster Stages of Recovery [CMSR] Leg and Foot).In all, 50 individuals (mean age, 60 ± 14 years; mean event-to-randomization, 23 ± 5 days; 29 men) participated. No adverse events occurred. BWSTT improved VO2peak by 30%, which was significantly greater than the 8% improvement observed for UC (P = .004 between groups). Similarly, there were significant Time × Group interactions for 6MWT and CMSR Foot, with BWSTT outperforming UC for gains in distance (P = .15; 48% vs. 19%, respectively) and stage (P = .01; 1.0 vs. 0.3, respectively). No group effect was seen for 10-m walk speed, BBS, or CMSR Leg, with both groups demonstrating significant gains. In general, gains observed were preserved for twelve months. BWSTT elicited greater improvementsin cardiovascular fitness and walking endurance than UC in the sub acute post stroke period. These gains are largely sustained for 1 year.

2.5.2. Flexibility

Mahalingam and Vairamani (2015) in their extensive investigation had indicated that the advantageous effect of physical activity on physical fitness and activities of daily living in older adults, but none had delved into the effects on the health of the women who had all along their life been helping everyone to enjoy life. This exploration studied the effect of an exercise program on Body Mass Index, Flexibility and Agility in women of age ranging from 40 to 50 years. Ninety (mean age 42.5 ± 5.5 years) women were randomly assigned to two treatment groups (n = 30) and a control group (n = 30) group and were evaluated before and after training. The treatment group completed an 8-week walking and guided yoga programs. Assessments included body weight and height, Boomerang Run Test (Right) for measuring agility and Sit and Reach Test for measuring Agility. ANCOVA revealed significant differences between groups ($p < .001$) for all measurements. Post-hoc test revealed that walking program had a higher effect in all the three fitness measures than yogic program.

Johnson and George (2010) concluded that the rapid emergence of nonalcoholic fatty liver disease (NAFLD) as a cause of both liverrelated morbidity and mortality and cardiometabolic risk had led to the search for effective lifestyle strategies to reduce liver

fat. Lifestyle intervention comprising dietary restriction in conjunction with increased physical activity has shown clear hepatic benefits when weight loss approximating 3%-10% of body weight is achieved. Yet, the poor sustainability of weight loss challenges the current therapeutic focus on body weight and highlights the need for alternative strategies for NAFLD management. Epidemiologic data showed an independent relationship between liver fat, physical activity, and fitness, and a growing body of longitudinal research demonstrates that increased physical activity participation per se significantly reduced hepatic steatosis and serum aminotransferases in individuals with NAFLD, independent of weight loss. Mechanistic insights to explain this interaction were outlined, and recommendations for the implementation of lifestyle intervention involving physical activity were discussed. In light of the often poor sustainability of weight loss strategies, and the viability of physical activity therapy, clinicians should assess physical fitness and physical activity habits, educate patients on the benefits of fitness outside of weight loss, and focus on behavior change which promoted physical activity adoption.

Song and Kim (2015) Purposed their study to assess the efficacy of a complex exercise program for the elderly, with respect to the effects on walking ability during direction change and on falls efficacy. In total, 40 subjects were selected for this study and assigned randomly to either a complex exercise (n = 20) or a general exercise (n = 20) group. The complex exercise consisted of resistance and aerobic exercises. The exercise program was conducted three times a week for eight weeks. We assessed outcome measures of the four square step test, the figure-of-8 walk test, and the falls efficacy scale. After the intervention, the four step square test, figure-of-8 walk test, and falls efficacy scale values increased significantly in both the complex exercise program and general exercise groups. The complex exercise group showed a more significant improvement than the general exercise group in the figure-of-8 walk test step and falls efficacy scale scores. [Conclusion] Complex exercise improved walking ability during direction change and falls efficacy in elderly individuals.

Kurt (2015) aimed to compare the effect of local vibration (LV) and whole body vibration (WBV) on lower body flexibility and to assess whether vibration treatments were more effective than traditionally used static and dynamic stretching methods. Twenty-four well-trained male combat athletes (age: 22.7 ± 3.3 years) performed four exercise protocols – LV (30 Hz, 4 mm), WBV (30 Hz, 4 mm), static stretching (SS), and dynamic stretching

(DS) – in four sessions of equal duration 48 hours apart in a randomized, balanced order. During a 15-minute recovery after each protocol, subjects performed the stand and reach test (S&R) at the 15th second and the 2nd, 4th, 6th, 8th, 10th and 15th minute. There was a similar change pattern in S&R scores across the 15-minute recovery after each protocol ($p = 0.572$), remaining significantly elevated throughout the recovery. A significant main protocol effect was found for absolute change in S&R scores relative to baseline ($p = 0.015$). These changes were statistically greater in LV than WBV and DS. Changes in SS were not significantly different from LV, but were consistently lower than LV with almost moderate effect sizes. After LV, a greater percentage of subjects increased flexibility above the minimum detectable change compared to other protocols. Subjects with high flexibility ($n = 12$) benefited more from LV compared with other methods (effect size ≥ 0.862). In conclusion, LV was an effective alternative exercise modality to acutely increase lower extremity flexibility for well-trained athletes compared with WBV and traditional stretching exercises

Boyd and Jacobsen (2014) wrapped up that older adults become less independent with age due to decreases in muscle mass, muscular power, neuromuscular facilitation, and range of motion. An estimated one in three older adults over the age of 65 experienced a fall annually. As a result, hip fractures might occur, which were fatal in 12%-20% of cases. The purpose of their study was to compare the immediate effects of whole body vibration (wbv) and walking on flexibility in individuals over age 65. Methods: participants (n=24) over the age of 70 years (m=77.80±8.64 years) were randomly assigned to a control group (cg), vibration training group (vg), or walking group (wg). Hamstring flexibility was tested at pre- and post-test utilizing the modified sit-and-reach. Each group received an intervention between measurements. Subjects in the cg sat for 10 minutes, wg participants walked for 10 minutes, and the vg completed a 10 minute vibration program at level five**.** Results: a group by time interaction did occur on the left (f=11.36, p=.000, η^2=0.52) and right (f=3.47, p=.05, η^2=0.25) hamstrings. Mean differences from pre- to post-test indicated significant improvements in right hamstring flexibility (p<.05) in the walking group from pre- (m=-10.32±-3.61 cm) to post-test (5.56 ±3.35 cm). Changes in the vibration training group approached significance (p=.079). Left hamstring flexibility significantly improved in the vg from -1.91±3.56 inches to -0.32±3.61 cm and wg from -11.27±3.56cm to -5.88 ±3.61 cm (p<.05). When comparing flexibility among all three groups, walking provided the largest improvement in flexibility. However,

the wg began at a lower level of flexibility than the other two groups, while the vg possessed the highest level of flexibility at pre-test. Evidence suggested that both WBV and walking could improve flexibility in older adults over 70 following a 10 minute intervention. Further research should examine the benefits of chronic training in order to expand empirical knowledge of wbv training and flexibility in older adults.

Kearney (2014) intended to examine whether 6 months of accumulated (3 × 10 minutes, 5 days/week) brisk walking was sufficient to reduce arterial stiffness in sedentary, overweight individuals. Seventy seven individuals (19 men, 58 women; age, 30-55 years) were randomly allocated to one of three groups; two groups completed 30 minutes of accumulated walking with either monthly or weekly telephone support; the third group (control) performed stretching exercises. The walking groups were combined and telephone support included as a covariate. Anthropometry, blood pressure (BP), blood lipids, pulse wave velocity (PWV), and NO_x (surrogate marker for nitric oxide) were measured at baseline, post-intervention and 4 months post-intervention. No changes were observed for anthropometry, BP, or lipids. However, at the end of the intervention, there was a decrease in PWV ($P < .001$) accompanied by an increase in NO_x($P < .001$), with changes maintained 4 months post-intervention. A strong negative correlation between PWV and $NO_x$was also observed ($P < .001$; $r = -0.65$). A lifestyle approach to meeting current physical activity guidelines resulted in favorable alterations in arterial function in overweight individuals.

2.6. Physiological variables

2.6.1. Resting pulse rate

Emerenziani GP et al. (2015) opined that in obese diabetic subjects, a correct life style, including diet and physical activity, was part of a correct intervention protocol. Thus, the aim of this study was to evaluate the effects of aerobic training intervention, based on resting pulse rate at aerobic gas exchange threshold, on clinical and physiological parameters in obese elderly subjects with type 2 diabetes (OT2DM). Thirty OT2DM subjects were randomly assigned to an intervention (IG) or control group (CG). The IG performed a supervised aerobic exercise training based on pulse rate at whereas CG maintained their usual lifestyle. Anthropometric measures, blood analysis, peak oxygen consumption, metabolic equivalent , work rate, and were assessed at baseline and after intervention. After training, patients enrolled in the IG had significantly higher and

significantly lower weight, BMI, %FM, and waist circumference than before intervention. Both IG and CG subjects had lower gyrated hemoglobin levels after intervention period. No significant differences were found for all the other parameters between pre- and post training and between groups. Aerobic exercise prescription based upon RPR could be a valuable physical intervention tool to improve the fitness level and metabolic equilibrium in OT2DM patients.

Mann (2015) aimed their study to determine the relationship between heart rate recovery (HRR) and an acute training "overload" by comparing HRR responses before and after an ultra-marathon road race. Ten runners completed a standardized laboratory protocol ~7 days before and between 2 and 4 days after participating in the 87 km Comrades Marathon. The protocol included muscle pain ratings, a 5 bound test and 20 min of treadmill exercise at 70% of maximal oxygen uptake followed by 15 min of recovery. Respiratory gases and heart rate measurements were used to calculate steady state exercise responses, HRR and excess post-exercise oxygen consumption (EPOC) and participants also provided a rating of perceived exertion during exercise (RPE). RPE was significantly increased (13+/-2 vs. 11+/-1)($p < 0.01$) and HRR was significantly faster (35+/-5 vs. 29+/-4 beats)($p < 0.01$) following the post- vs. pre-race submaximal exercise bout with no significant changes in respiratory- or heart rate- parameters during exercise or in EPOC. Although previous studies had shown that faster HRR reflected an "adapted" state with enhanced training status, the current findings suggested that this might not always be the case. It followed that changes in HRR should be considered in the context of other factors such as recent training load and RPE during submaximal exercise.

Donath et al. (2014) found that stair-climbing served as a feasible opportunity to remain physically active within everyday-life. Data on neuromuscular and cardio respiratory performance after regular stair-climbing in seniors were scarce. Forty-eight seniors were stratified to a one- (taking every step, INT_1) or two-step strategy (every second step, INT_2) or a control group (CON). Thirty-nine seniors [females: $n = 22$, males: $n = 17$; age: 70.5 (SD 5.1) years; BMI: 25.8 (3.1) kg/m^2] completed the 8-week intervention (three weekly sessions). Before and after the intervention, balance, gait, strength, and submaximal endurance (at different intensities) were assessed. Maximal strength and explosive power did not improve significantly ($0.10 < P < 0.78$). Resting heart rate was significantly reduced in INT_2 (−8/min) compared with

INT_1 (0/min, P□=□ 0.02) and CON (0/min,P□=□ 0.03). Compared with CON, perceived exertion for all intensities (0.007□ <□P□<□ 0.03) and sub maximal exercise heart rate during moderate uphill walking significantly decreased (−11/min; P□<□ 0.05) in INT_2. Step counts for forward beam balancing (4.5□ cm width) increased in INT_2 (P□=□ 0.007) compared with CON. With more pronounced effects in INT_2, stair-climbing significantly improved resting and exercise heart rates, perceived exertion, and dynamic balance performance in healthy seniors and may contribute to better overall fitness, reduced fall risk, and less perceived strain during daily life activities.

Morris et al. (1997) concluded in their study that walking, by quantity and pace, was under-researched, particularly in the middle aged and elderly. Randomized controlled trials were required of its physiological effects on blood pressure, thrombogenesis, immune function; and of walking in the prevention and/or treatment of non-insulin dependent (type II) diabetes mellitus, osteoporosis, anxiety and depression and back pain. They concluded that low levels of walking were a major factor in today's widespread waste of the potential for health and well-being that was due to physical inactivity. This waste was manifest in impaired functional capacities, overweight, disease, disability, premature death and the concomitant human and economic costs. This review sought to assemble evidence of the health gains of walking as a resource for the multifarious professionals and students, practitioners, investigators and policy makers.

2.6.2. Vital capacity

Watanabe (2015) cautioned that lack of exercise was one of the main factors of life style disease. It was known that aerobic exercise was effective for preserve and promote of health. In the recent years, aerobic exercises were performed by many people for awareness to health. Walking was selected as exercise for health in many cases, to walking technique was easy to practice even for beginners. Improved exercise intensity of walking was reported various researcher, but there was no verification of walking effect of sandy beach. The purpose of this study was to investigate cardio respiratory response during sandy beach walking. Healthy eleven men and women participated in this study after informed consent. There physical characteristic were as follows; age, 23.1 ± 5.7years, height, 169.9 ± 9.3 cm; body weight, 63.6 ± 7.5 kg. Participants were walked sandy beach and asphalt road for 15 minutes. Average walking speed were adjusted 3 and 4 km per hours by speed mater. Heart rate response was measured every 5seconds. In addition,

oxygen uptake and heart rate response during treadmill walking were measured at 10 second intervals, and to determine the relationship between oxygen uptake and heart rate. Oxygen uptake of sandy beach and asphalt road walking were estimated by the relationship of oxygen uptake and heart rate. Statistical processing was used one way repeated measures of analysis of valiance. Statistical significance was accepted at $p < 0.05$. The result of this study, Heart rate response and oxygen uptake of sandy beach walking were significant higher than asphalt road in both speed. Consequently, it was clear that sandy beach walking was benefit as health exercise than asphalt road walking.

Kostrzewa-Nowak (2015) concurred that numerous data suggest that aerobic-type exercise improved lipoprotein-lipid profiles, cardio respiratory fitness and body composition in young women. The aim of this study was to evaluate the biological response to high-low impact aerobic fitness among young women. A group of thirty-four young women aged 22 (19-24) years was divided into three groups: underweight (N = 10), normal weight (N = 12) and overweight (N = 12). Aerobic capacity, anthropometry and body composition together with complete blood count and lipid profile were determined before and after completion of a 12 week long training period, results of the training programme caused a significant decrease in weight (by 4.3 kg, P = 0.003), body mass index (by 1.3 kg/m2, P = 0.003), free fat mass (by 2.1 kg, P = 0.002), total body water (by 0.4 kg, P = 0.036), percentage of fat (by 3 percent points, P = 0.002), all analyzed skin folds thicknesses, as well as the lipid profile in overweight group, and no changes in normal weight group. Significant changes in weight (by 4.2 kg, P = 0.005), body mass index (by 0.9 kg/m2, P = 0.005), skin fold thickness (by 3.3 mm, P = 0.028), and in maximum oxygen uptake (by 2.49 mL/kg/min; P = 0.047) were observed among underweight women. No change in total blood count was observed in all groups. Conclusion of this study is twelve-week-long fitness training programme of two alternating styles (low and high impact) has a beneficial effect on overweight young women.

Dragoi (2015) evaluated the impact of inspiratory muscle training on aerobic capacity and pulmonary function in patients with ankylosing spondylitis through a randomized controlled study. 54 ankylosing spondylitis patients, all males, were randomized to a conventional exercise training associated with an inspiratory muscle training group, or to a conventional exercise training group. Interventions group 1 (27 patients) performed eight weeks of conventional exercise training (supervised weekly

group sessions followed by a home-based exercise programme) associated with inspiratory muscle training sessions. Group 2 (27 patients) received eight weeks of conventional exercise training only. Main measures on resting pulmonary function (forced vital capacity − FVC, forced expiratory volume in one second − FEV1); effort ventilatory efficiency (lowest ventilatory equivalent ratio for oxygen and carbon dioxide – VE/VO_2 and VE/VCO_2) and aerobic capacity (peak oxygen uptake – VO_2peak) were assessed at baseline and after eight weeks of exercise-based intervention. Results is after eight weeks follow-up, patients in Group 1 had a significant increased chest expansion and VO_2peak compared with Group 2 (3.6 ±0.8□ cm vs. 3.2 ±0.5□ cm,*P*□ =□ 0.032; 2.0 ±0.5□ l/min vs. 1.8 ±0.3□ l/min,*P*□ =□ 0.033). There were no significant differences of spirometric measurements, except FVC which significantly improved in patients who performed inspiratory muscle training (82.7 ±5.1% vs. 79.5 ±3.5%, *P*□ =□ 0.014). VE/VCO_2 also improved significantly in Group 1 (26.6 ±3.6 vs. 29.2 ±4.7, *P*□ =□ 0.040). Finally ankylosing spondylitis patients who performed eight weeks of inspiratory muscle training associated to conventional exercise training had an increased chest expansion, a better aerobic capacity, resting pulmonary function and ventilatory efficiency than those who performed conventional exercise training only.

Sharma H (2015) compared the peak flow rate and vital capacity between district level and state level FOOTBALL players. The subjects consisted of 30 (District level:15 and State level:15) randomly selected male FOOTBALL players, between the age group of 18 to 28 years, studying at different colleges affiliated to Guru Nanak Dev University, Amritsar, Punjab, India. Peak flow rate was measured with a peak flow meter whereas vital capacity was measured by spirometer.The between-group differences were assessed by using t-test. The level of $p<0.05$ was considered significant.

Dominelli, Sheel and Foster (2012) used **w**eighted backpacks extensively in recreational and occupational settings, yet their effects on lung mechanics during acute exercise was poorly understood. The purpose of this study was to determine the effects of different backpack weights on lung mechanics and breathing patterns during treadmill walking. Subjects (n = 7, age = 28 ± 6 years), completed two 2.5-min exercise stages for each backpack condition [no backpack (NP), an un-weighted backpack (NW) or a backpack weighing 15, 25 or 35 kg]. A maximal expiratory flow volume curve was generated for each backpack condition and an oesophageal balloon catheter was used to

estimate pleural pressure. The 15, 25 and 35 kg backpacks caused a 3, 5 and 8% ($P < 0.05$) reduction in forced vital capacity compared with the NP condition, respectively. For the same exercise stage, the power of breathing (POB) requirement was higher in the 35 kg backpack compared to NP (32 ± 4.3 vs. 88 ± 9.0 J min(-1), $P < 0.05$; respectively). Independent of changes in minute ventilation, end-expiratory lung volume decreased as backpack weight increased. As backpack weight increased, there was a concomitant decline in calculated maximal ventilation, a rise in minute ventilation, and a resultant greater utilization of maximal available ventilation. In conclusion, wearing a weighted backpack during an acute bout of exercise altered operational lung volumes; however, adaptive changes in breathing mechanics may have minimized changes in the required POB such that at an iso-ventilation, wearing a backpack weighing up to 35 kg does not increase the POB requirement.

2.7. Biochemical variables

2.7.1 Random blood sugar

Hagner Derengowska (2015) conducted a study with 196 women who enrolled in the study of 147 (75%) completed the study; among those women, 69 (47%) completed a 10-week NW exercise program, 58 (39%) completed a 10-week Pilates exercise program, and 20 (14%) were in the control group. After 10 weeks, women in the NW group showed a significant reduction in body weight (6.4%), body mass index (6.4%), blood glucose (3.8%), total cholesterol (10.4%), non-high-density lipoprotein (HDL) cholesterol (16.7%), low-density lipoprotein cholesterol (12.8%), and triglycerides (10.6%), as well as an increase in HDL cholesterol (9.6%). Significantly smaller-although still favorable-changes, except for glucose and HDL cholesterol levels, were observed in the Pilates group (decreases of 1.7%, 1.7%, 1.6%, 5.3%, 8.3%, 7.5%, and 6% and an increase of 3.1%, respectively). Nevertheless, at the end of the study, the percentage of women with target concentrations of the lipid fractions had significantly increased in both exercise groups. No significant changes in the studied parameters were found in the control group. On multiple regression analysis, type of exercise program was an independent predictor of amplitude changes in most of the studied parameters.

Deguchi et al. (2015) were aware of several guidelines that had recently recommended exercise for prevention and treatment of type 2 diabetes. However, determining the optimum exercise conditions, e.g., the intensity, amount, frequency, and

type of exercise, is difficult, particularly by patients themselves. They had investigated the acute effect of fast walking on postprandial blood glucose levels among patients with type 2 diabetes. Fourteen patients diagnosed with type 2 diabetes at least 1 year previously were eligible for inclusion in this study during educational hospitalization. Three walking programs, natural walking (walking at a natural speed), 10 % fast walking, and 20 % fast walking, were performed 1 h after lunch in a randomized sequence with a washout period of 1 day. Walking time was 30 min in all the programs. Primary outcome was determined by self-monitoring of blood glucose. Blood glucose levels were measured before walking, after walking for 15 min, and at the end of walking. Heart rate and systolic and diastolic pressure were also measured for safety reasons. All the participants completed the study with no adverse effects. Compared with natural walking, fast walking markedly improved postprandial glucose excursion in an intensity-dependent manner without any adverse effects. Fast walking acutely reduced postprandial blood glucose levels among patients with type 2 diabetes. Our method has major implications for the practice of diabetes education in clinical rehabilitation.

Shahgholian et al. (2015) In their study they had found no significant differences between the test and control groups in terms of the mean FBS and 2-h PPBS levels before the intervention. Moreover, the mean FBS and 2-h PPBS levels of the control group did not show significant changes throughout the study. In the test group, however, eight sessions of aerobic exercise could make statistically insignificant reductions in both the mentioned values. The reductions turned to be significant after the 16^{th} session. Mikas *et al*. reported 7 days of aerobic exercise to have no significant effects on FBS levels and considered low number of sessions as the possible reason.Generally, 40 min of pedaling on a stationary bicycle, twice weekly for 8 weeks is accepted to significantly lower FBS and 2-h PPBS levels in patients undergoing continuous ambulatory peritoneal dialysis. In a study on 16 patients undergoing continuous ambulatory peritoneal dialysis, indicated that 12 weeks of treadmill workout significantly decreased the patients' mean FBS from 95.4 ± 12.6 to 90 ± 10.8 mg/dl. Walking can also be effective in controlling blood sugar. In 2011, Ahmadi and Ghajari evaluated the effects of an 8-week course of walking on blood sugar levels of 20 patients with type II diabetes. At the end of the study, they found the intervention group to have significantly lower mean FBS compared to the control group. In a 6-week study, examined the effects of walking on the mean blood sugar of 10 non–insulin-dependent diabetics. At the end of the study, they identified the intervention group

to have significantly lesser mean FBS and 2-h PPBS levels compared to the control group. They concluded that since working muscles are more sensitive to insulin, aerobic exercise facilitates glucose uptake by the muscles, and can thus be a definitive tool in blood glucose control.

Yates T et al. (2013) investigated associations of self-reported and objectively assessed walking activity with measures of glucose regulation in a multi-ethnic population at high risk of type 2 diabetes. This study reported data from a 2009-2011 screening programme for impaired glucose regulation (IGR) within a high-risk primary care population in Leicestershire, UK; 2532 participants (38% women, 8% South Asian) with a mean age of 64 ± 8 years and an average BMI of 32.1 ± 5.6 kg/m(2) were included. Walking activity was measured by self-report (International Physical Activity Questionnaire) and objectively (pedometer). Glucose regulation assessments included 2h post-challenge glucose, fasting glucose and HbA1c. Higher levels of self-reported walking activity and pedometer steps were associated with lower 2h post-challenge glucose after controlling for several known confounding variables, including BMI. Similarly, when categorized in tertiles, both measures were associated with a lower odds of having any form of IGR; odds ratio for lowest vs highest tertile was 0.64 (0.51-0.80) for self-report and 0.69 (0.55-0.87) for pedometer steps. There was no significant difference between self-reported and objective measures in the strength of associations with glucose regulation; associations with self-report were maintained when further adjusted for pedometer steps. Stronger associations between self-reported walking activity and glucose regulation were observed in South Asians compared with White Europeans. Self-reported and objectively measured walking activities were equally associated with indices of glucose regulation. Associations with self-reported walking activity were maintained when further adjusted for pedometer steps, suggesting that self-reported walking activity may measure facets of physical activity that are beyond total volume.

Nishida et al. (2010) explained that increased concentrations of circulating insulin-like growth factor-I (IGF-I) or IGF-I relative to IGF-binding proteins (IGFBPs) were associated with increased risk of developing several forms of cancer. Conversely, exercise was linked with reduced risk. This study aimed to investigate the effect of a low-intensity exercise program on circulating levels of IGF-I, IGFBP-1, and IGFBP-3, in previously

sedentary males. Fourteen healthy men participated in cycle ergometer training at lactate threshold intensity for 60 min/day, 5 days/week for 6 weeks. After aerobic training, insulin sensitivity improved by 20%, while fasting insulin levels decreased by 13%. Simultaneously, low-intensity aerobic training decreased the circulating levels of IGF-I by 9%, while IGFBP-1 levels increased by 16%. An interesting finding was that higher pretraining level of IGF-I was associated with greater decline in IGF-I with training. Insulin-sensitizing low-intensity aerobic exercise is thus considered to be an effective method for downregulating IGF-I and upregulating IGFBP-1 levels.

2.7.2. Lipids

Mahgoub and Aly (2015) investigated the efficacy of 8 weeks of continuous or intermittent exercise on lipid profile in obese children. A randomised pre-test—post-test design was implemented to compare the effects of continuous and intermittent exercise, measuring lipid profiles in obese children before and after the intervention. Thirty obese children (11 male and 19 female; age range: 12-15 years; body mass index ≥25) were randomised into two exercise intervention groups to engage in an 8-week exercise programme consisting of either continuous exercise (Group A) or intermittent exercise (Group B). Results: Data showed that there was a significant decrease in total cholesterol, triglycerides and low-density lipoprotein (LDL) cholesterol and a significant increase in high-density lipoprotein (HDL) cholesterol in both groups following intervention. There was a significant improvement in the lipid profile results of Group B compared with Group A. Conclusions: Intermittent exercise programmes are more effective than continuous exercise programmes in improving lipid profiles in children with obesity. Findings from this research could lead to improved health outcomes in obese patients by increasing aerobic capacity, wellness and metabolic fitness.

Lian et al. (2014) with a purpose to examine the influence of walking at different times of day on lipids and inflammatory markers in sedentary patients with coronary artery disease (CAD). The authors chose a total of 330 patients recruited from Nanjing between September 2011 and November 2012 and randomly assigned to a control group (n=110), morning (n=110) or evening walking group (n=110). Both the walking groups were asked to walk 30 min/day or more on at least 5 days/week either in the morning or evening for 12 weeks. Lipids and inflammatory markers were measured before and after exercise intervention. Results, Compared with baseline, total cholesterol (TC), low-density

lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) were improved in all groups. Significances were shown in the changes of fibrinogen, high sensitivity C-reactive protein (hscrp), white blood cell (WBC) count, TC, triglycerides, LDL-C, lipoprotein(a) between groups. The evening walking group had a larger decrease in fibrinogen (0.16 ± 0.19 g/L, P<0.001), hscrp (1.16 ± 1.07 mg/L, P<0.001), WBC count (0.76 ± 1.53·10(9)/L, P=0.004) and LDL-C (0.34 ± 0.31 mmol/L, P<0.001) than the other two groups. Conclusions, our walking program successfully resulted in a favorable change in lipids and inflammatory markers. Patients in the eveningwalking group gained more benefits than those walking in the morning walking group.

Aguiló et al. (2003) evaluated the effect of different intensity of exercise and different raining status on antioxidants and cholesterol profile in cyclists. 33 male cyclists (17 amateur and 16 professional cyclists) participated in this study. The amateurs all trained 14 ± 1 h each week, and their VO_2 max was 62.5 ± 1.8 ml/Kg.min; the professionals all trained 24 ± 1 h each week, and their VO_2 max was 80.2 ± 1.6 ml/Kg.min. Amateurs were submitted to the maximal and submaximal prolonged exercise tests. Professionals were submitted to a mountain stage (170 km) of cycling competition. Serum lipid and cholesterol profile (triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and VLDL-cholesterol) and plasma antioxidant capacity (ascorbic acid, α-tocopherol, retinol, β-carotene and others) were measured before and after exercise tests. Hematological determinations (number of erythrocytes, hematocrit and hemoglobin concentration) and dietary intake were also measured. No significant differences were observed in basal values (before exercise tests) of amateur and professional cyclists. Negligible differences were found between dietary intake of amateur and professional cyclists, and also the results of hematological values showed there was no effect of degree of hydration or dietary intake on blood levels of studied antioxidant and lipid parameters. An increase in plasma levels of vitamin C, vitamin E, triglycerides and VLDL-cholesterol levels, and also a decrease of β-carotene and LDL-cholesterol. were observed in well-trained professional cyclists after the cycling stage - an endurance exercise - but not in amateur cyclists. Amateur cyclists showed only mild increases in total cholesterol after maximal and submaximal exercise, while a rise in HDL-cholesterol was only observed after maximal exercise; none of these changes were observed in professional cyclists. Plasma levels of antioxidant vitamins and carotenes, and also serum lipids, total cholesterol and lipoprotein-cholesterol showed an overall response to exercise, and their increase

and/or decrease must be explained as a consequence of the different training status of sportsmen and intensity and duration of exercise tests.

Hashimoto et al. (2013) investigated the acute effects of postprandial exercise on glucose and lipoprotein metabolism after the intake of glucose with or without fat cream in healthy but sedentary young women. Healthy young Japanese women with a sedentary lifestyle, normal weight, normal ovarian cycle, and apolipoprotein (apo) E3/3 were enrolled as participants. They ingested 1 g/kg body weight of glucose only or glucose supplemented with 1 g/kg oral fat tolerance test (OFTT) cream 4 (0.35 g/kg as fat) with or without postprandial walking exercise on a motorized treadmill (ca. 50%V(·)o(2)max for 30 min) 20 min after intake of the beverage. Each subject performed 4 trials in a randomized, cross-over design. Venous blood was drawn before (0 h), and 20 min, 1, 2, 4, and 6 h after ingestion. Postprandial exercise alleviated the sharp rise of serum glucose and insulin, and transiently mitigated the decrease of free fatty acids (FFA) after ingestion of the glucose-only beverage. Although no fat was contained in the glucose beverage, transient apoB48 secretion was observed without the rise of serum triglyceride (TG) and remnant-like particle (RLP)-TG, suggesting that apoB48-containing lipoprotein particles with little TG were released by the exercise. Serum apoB48 concentrations at 6 h had decreased to levels lower than the baseline (0 h, after 12-h overnight fast) with or without exercise, suggesting that the 12-h overnight fast may not have been a 'true' fast. Similarly, postprandial exercise suppressed the sharp rise of serum glucose and insulin, and transiently mitigated the decrease of FFA after the ingestion of glucose with OFTT cream. Postprandial exercise stimulated the transient secretion of apoB48-containing TG-rich lipoproteins (TRL) with a rapid rise of serum apoB48, TG, and RLP-TG; however, the subsequent course of lipemia was not significantly changed. Serum apoB48 and RLP-TG values did not return to the baseline even after 6 h, suggesting that postprandial lipoprotein metabolism was not finished at the end of the experiment. Postprandial aerobic exercise alleviated the glycemic peak at 1 h associated with insulin 'sparing'. The effect of exercise on fat metabolism was transient, enhancing the secretion of intestinal TRL at an early phase, but no further significant effects were observed. Postprandial exercise transiently stimulated the secretion of apoB48 after glucose intake without a fat load.

Couillard et al. (2001) studied and endorsed that high density lipoprotein (HDL) cholesterol concentrations had been shown to increase with regular endurance exercise

and, therefore, could contribute to a lower risk of coronary heart disease in physically active individuals compared with sedentary subjects. Although low HDL cholesterol levels were frequently observed in combination with hypertriglyceridemia, some individuals might be characterized by isolated hypoalphalipoproteinemia, ie, low HDL cholesterol levels in the absence of elevated triglyceride (TG) concentrations. The present study compared the responses of numerous lipoprotein-lipid variables to a 20-week endurance exercise training program in men categorized on the basis of baseline TG and HDL cholesterol concentrations: (1) low TG and high HDL cholesterol (normolipidemia), (2) low TG and low HDL cholesterol (isolated low HDL cholesterol), (3) high TG and high HDL cholesterol (isolated high TGs), and (4) high TGs and low HDL cholesterol (high TG/low HDL cholesterol). A series of physical and metabolic variables was measured before and after the training program in a sample of 200 men enrolled in the Health, Risk Factors, Exercise Training and Genetics (HERITAGE) Family Study. At baseline, men with high TG/low HDL cholesterol had more visceral adipose tissue than did men with isolated low HDL cholesterol and men with normolipidemia. The 0.4% (not significant) exercise-induced increase in HDL cholesterol levels in men with isolated low HDL cholesterol suggests that they did not benefit from the "HDL-raising" effect of exercise. In contrast, men with high TG/low HDL cholesterol showed a significant increase in HDL cholesterol levels (4.9%, $P<0.005$). Whereas both subgroups of men with elevated TG levels showed reductions in plasma TGs (≈−15.0%,$P<0.005$), only those with high TG/low HDL cholesterol showed significantly reduced apolipoprotein B levels at the end of the study (−6.0%, $P<0.005$). Multiple regression analyses revealed that the exercise-induced change in abdominal subcutaneous adipose tissue (10.6%, $P<0.01$) was the only significant correlate of the increase in plasma HDL cholesterol with training in men with high TG/low HDL cholesterol. Results of the present study suggest that regular endurance exercise training may be particularly helpful in men with low HDL cholesterol, elevated TGs, and abdominal obesity.

2.8. Summary of Related Literature

In order to have a comprehensive picture and current status of walking as exercise and its benefits, research studies conducted in this area were reviewed. On the basis of the review of related literature research and from the above discussion, newer teaching methods to the improvement in sports performance as well as physical fitness by aerobic exercises had been established. The research studies reviewed were from many journals

available in the internet websites. The extensive survey of the literature could procure a lot of information related to the study on walking on different surfaces and the effects of walking on different surfaces on the physical, physiological and biochemical variables. These literatures might be of great help in the process of analysis of the findings of the study and the interpretations of the results obtained.

Chapter III

METHODOLOGY

In this chapter, the methodology adopted for the selection of subjects, selection of variables, selection of tests, orientation of subjects, orientation of testing personnel, calibration of instruments, reliability of data, test administration of motor ability, collection of blood sample, estimation of biochemical variables, experimental protocols, collection of data, experimental design and statistical techniques have been presented.

3.1. Selection of Subjects

In the present study an effort was made to select the subjects among the obese people from Chennai city, Tamil Nadu. The subjects were directed to assemble in a park to seek their willingness. The investigator explained to them the purpose, importance of experiment and the procedure to be employed to collect the blood. Further, the role of subjects during experimentation and testing period were also explained. Hundred and twenty subjects were selected by random sampling technique. Their age ranged from 40 to 45 years. All the subjects were over healthy. The subjects were divided in to four equal groups of thirty each at random method. There were no dropouts in the study and the entire subjects cooperated well during the experimentation and testing periods.

3.1.1. Rationale used for the Selection of Subjects

For any research the subjects should be selected carefully. By considering the purpose of the study one hundred twenty subjects were selected randomly. The subjects were considered large enough and true representatives of the population. Above all these subjects were adequate to draw meaningful conclusions and generalizations.

3.2. Selection of Variables

The investigator referred different relevant literatures and consulted with experts in sports physiology and exercise biochemistry to identify the most suitable variables. The variables selected are furnished below.

Dependent Variables

The criterion variables selected in the study were motor fitness, physiological variables, and biochemical variables.

3.2.1. Motor fitness variables

i. Cardio vascular fitness

ii. Flexibility

3.3.2 Physiological variables

i. Resting pulse rate

ii. Vital capacity

3.3.3 Biochemical variables

i. Blood sugar

ii. Blood lipids

3.3. Independent variable

3.3.1. Walking in different surfaces

3.4.1.1 Mud surface walking

Fig. 3.1 Mud surface walking

Walking on softer surfaces such as mud, sand or grass also uses more energy than walking on concrete. Every time your foot hits the ground, it creates a small depression so that the leg muscles must work harder to push upwards and forwards for the next step. Walking on cobblestones or rocky ground may have even more benefits. Physiologists at the Oregon Research Institute have found cobblestone walking lowers blood pressure and improves balance. The uneven surfaces may stimulate acupressure points on the soles of the feet, regulating blood pressure. Because it is challenging, it will also burn more calories.(*Mud walking* n.d)

3.4.1.2. Concrete surfaces

Back pain can strike anyone, at any point in life. In the U.S., it is the most frequent excuse for missed work and the most common pain complaint. If you have concrete flooring at your job or home, the etiology of your back pain could stem from walking on those hard floors. The body is built with natural shock-absorbers, but even these systems can fail after repeated abuse from concrete flooring. Learn how to care for your back and eliminate back pain caused by those floors.(C*oncrete surface*, n.d.,)

Fig. 3.2 Concrete surfaces

Adult sheep were subjected to prolonged activity on hard surfaces by walking them daily on concrete and housing them on tarmac. Control sheep were walked on compliant wood chip surfaces and pastured. After two and a half years significant changes were seen in both the distal femoral articular cartilage and subchondral trabecular bone of the knee joints of the hard surface walkers. The hexosamine content of the articular cartilage in the hard surface walkers was lower and this decrease was more marked in the weight-bearing than in the non-weight-bearing areas of the knee. The trabecular pattern of the subchondral bone became significantly altered, with a marked change in trabecular structure acting to stiffen the tibio-femoral joint at th expense of the patello-femoral articulation. There was a substantial increase in the contiguity ratio of bone in the tibio-femoral area. The cortical thickness of the subchondral plate was increased in both the tibio-femoral and patello-femoral areas. We concluded that significant changes occur in both cartilage and bone as a result of prolonged walking on hard surfaces.(C*oncrete surface*, n.d.,)

3.4.1.3. Road surfaces

The network of roads and streets across Britain is an important part of the walking environment, particularly for most everyday trips. Even if you're following a route that's mainly along footpaths, the chances are you will have to follow roads for part of the way. Walkers have as much right to be on the majority of roads and streets as everyone else – including drivers.

Fig 3.3 Road surfaces

This includes most roads with no separate pavements. Only motorways and a few other designated fast roads are legally closed to walkers. However, it is important for your safety that you follow the Highway Code when using roads and streets. While fast traffic has made many roads and streets unwelcoming places for walkers, in some areas initiatives like Home Zones and Quiet Lanes have helped create more walking friendly environments, without excluding motorists altogether. Shared space is where the traditional boundaries between walkers and vehicles, like kerbs, signs, distinct surfaces and road markings, have been minimised or removed, encouraging all users to share the same surface. It is most common in town centres and urban squares and spaces where there are large numbers of walkers. In residential areas, it's often a component of a Home Zone. Although shared space has been shown to reduce accidents and to encourage walking and cycling, it is sometimes controversial, with some people with disabilities, particularly blind and partially sighted people, reporting they find it difficult to negotiate. (*Road surfaces* n.d)

During training period there should be proper combination among training and rest period. Walking on different surface may influence motor fitness, physiological variables and Biochemical variables. By considering the purpose of the study, availability of equipments and

lab test facilities above, mentioned physiological variables, motor fitness and biochemical variables were selected in the present study. Each groups consisted of 30 obese men who walk daily for 45 minutes for five days in a week under the supervision of the scholar in ground , mud, concrete and road walking between 5 and 6 am. Every day for 45 minutes, the distance did not measure. They were requested to give their feedback about their convenience or otherwise.

3.5. Motor fitness

Motor fitness is the key to success in sports and games as well as general fitness. Various sports differ in their requirements for different motor ability for success. The walking is one of the ways to improve various motor fitness. Therefore, in this study

i) Cardiovascular fitness

ii) Flexibility were selected.

3.6. Physiological variables

Physiology plays a vital role in the field of physical education, and also in general fitness. There were lot of physiological functions interfere in the fitness platform. Among that we selected resting pulse rate and vital capacity as physiological variables for this study. Aerobic exercises may influence physiological functions highly. One of the aerobic exercises is walking, where the following variables were selected for finding the changes in Resting pulse rate and Vital capacity.

3.7. Biochemical Variables

Exercise biochemistry also one of the most important areas of research in physical education and general fitness. The biochemical variables which are closely associated with aerobic training such as:

i) Blood sugar

ii) High density lipoprotein

iii) Low density lipoprotein were selected.

3.8. Selection of Tests

Table 1: Tests for Selected Criterion Variables

S.no	Variables	Method/Equipment	Units of measurement
1	**Motor fitness**		
	i. Cardiovascular fitness	12 min cooper test	Distance in meters
	ii. Flexibility	Sit and reach test	Centimeter
2	**Physiological Variables**		
	i. Resting pulse rate	Radial pulse rate	Beats/Minute
	ii. Vital capacity	Lung function test (Peak flow meter)	ltr/ one breath out
3	**Biochemical variables**		
	i. Random Blood sugar	All the tests were done by a reputed biochemical laboratory	mg/dL
	ii. High density lipoprotein		mg/dL
	iii. Low density lipoprotein		mg/dL

The present study was undertaken primarily to critically analyze the walking on different surfaces on selected motor, physiological and biochemical variables among obese men and the age groups between 40 and 45 years. From the available literature, the following standardized tests were selected and used to collect relevant data pertaining to the selected dependent variables and are presented in Table1.

3.9. Tester Competency

Even though many tests were available, the investigator has selected the above mentioned tests, because, they are standardized tests and most suitable to quantify the chosen variables.

The different surface walking was given to experimental group under the direct supervision of investigator. The procedure of conducting the tests and method of scoring were explained as well as demonstrated by the investigator to enrich the tester's reliability. The biochemical variables were estimated by the experts in the Government Primary Health Centre, Valasaravakkam, Chennai.

3.10. Reliability of Instruments

The standard equipments were purchased from reputed companies and all the equipments were new and in good condition.

The blood samples were analyzed in the biochemical laboratory at Government Primary Health Centre, Valasaravakkam, Chennai. For blood test standard equipments, reagents and chemicals were used. Sophisticated and computerized equipment was used to assess the biochemical variables.

The equipments used to assess criterion variables are standard, new and in good condition. Hence, their calibrations were accepted as accurate enough to collect the data for research purpose.

3.11. Reliability of Data

Before the commencement of the experiment, reliability of the data was established. For this purpose, 10 subjects were selected randomly among the obese people from Chennai, Tamilnadu. To ensure reliability, pre test and post test was followed. All the criterion variables selected in the presented study were tested twice for the same subjects under similar conditions at the interval of a week. The stopwatch and peak flow meter were purchased from reliable and branded companies and were considered to be accurate enough. The Blood tests were made with the help of a famous and reliable laboratory for measuring, random blood sugar, low density lipoprotein and high density lipoprotein. The resting pulse rate was done by the trainees themselves through the radial artery for 60 seconds.

3.12. Orientation of the Subjects

The purpose of the study and the significance of training & tests were explained to the subjects understandably. All the subjects of experimental groups were motivated to perform

the training correctly. For both experimental and control groups the procedures for each test was explained clearly and demonstrated for clear view. All the subjects were motivated to perform better during the test. The recording of measurements of each test item was made known to them to familiarize about their performance. All the subjects of experimental group attended all the training sessions regularly. Further, all the subjects of both control and experimental groups performed all tests to their maximum ability.

3.13. Administration of Tests

3.13.1 Resting pulse rate

Purpose

The purpose of this test was to measure the resting pulse rate of the subjects.

Equipment used

Oximeter Finger Device available in the lab.

Procedure

The measurement of resting pulse rate was the number of heart beats per minute and it was taken after a few minutes upon reaching the test centre. The subjects were asked to give some time to adjust to the change from sleeping before taking their pulse (2-5 minutes).

Fig.2 Oxymeter finger device

Scoring:

The subjects were asked to stick their finger in it, and a few seconds later Oximeter finger device gave the pulse, as well as some oxygen reading. The scholar did not use that second number but the pulse rate was noted as beats per minute. (*Oximeter finger device* n.d

3.13.2 Vital capacity

Purpose

To find out the vital capacity of subject

Equipment required

Peak flow meter, which can come as a small pocket sized machine.

Fig.3 Peak flow meter

Procedure

1. It was made sure that the subjects had no food or gum in their mouth and the subject stood up.
2. The pointer was put on the gage of the peak flow meter at 0.
3. The mouthpiece was attached to the peak flow meter.
4. The subject took a deep breath, then placed the peak flow meter mouthpiece in their mouth and closed their lips tightly around the outside of the mouthpiece and the subjects were advised not to their tongue inside the mouthpiece.

5. They breathed out as hard and as fast as possible (using a "huff" rather than a full breath out). The value was recorded on the gage before moving the pointer on the gage back to 0.

Scoring

Three attempts were given for each subject and the best record was chosen as the score.

3.13.3. Cardiovascular fitness

The Cooper 12 minute run a popular maximal running test of aerobic fitness, was used in which participants tried and covered as much distance as they ccould in 12 minutes.

Purpose

To test aerobic fitness and cardiovascular endurance (the ability of the body to use oxygen to power it while performing any physical task involving all te systems of the body)

Equipment required

A 400 metres mud running track, marker, recording sheets and stop watch.

Procedure

Markers were placed at set intervals around the track to aid in measuring the completed distance. When the scholar said start, participants started walking and at the end of 12 minutes, the scholar gave a long whistle to stop walking. The total distance covered by each subject was recorded as the score. The participants were encouraged to push themselves as hard as they could to maximize the distance covered. If they felt any discomfort while walking fast, they were advised to stop and sit there itself to avoid any medical complications. But all the subjects completed the test successfully.

Scoring

The total distance travelled either by running, or by walking or by both by every subject in 12 minutes was recorded in metres as their score in cardiovascular endurance test.

3.13.4 Flexibility

3.13.4.1. Sit and Reach Flexibility Test

A common test to measure the flexibility of hips and hamstring muscles, the sit and reach test was used in this study. This test was first described by and is now widely used as a general test of flexibility. (Wells and Dillon 1952)

Test Procedure

The basic outline of the sit and reach test has been described below.

Equipment required

Sit and reach box with a ruler was used.

Fig.4 Sit and Reach Flexibility Test

Procedure

This test involved sitting on the floor with legs stretched out straight ahead. The subjects were asked to remove their shoes. The soles of the feet were placed flat against the box. Both knees were locked and pressed flat to the floor - the tester was assisting by holding the subjects down. With the palms facing downwards, and the hands on top of each other or side by side, the subjects reached forward along the measuring line as far as possible. It was ensured that the hands remained at the same level, not one reaching further forward than the

other. After some practice reaches, the subject reached out and held that position for at one-two seconds while the distance was recorded. It was made sure that there were no jerky movements.

Scoring

The score was recorded to the nearest centimeter as the distance reached by the hand. (*Sit and reach test*, n.d)

3.13.5. Lipoproteins and Blood sugar

Low density lipoprotein, high density lipoprotein and random blood sugar were measured on the same day in the ground. A well qualified lab technician collected the blood samples from all the subjects by 10 am. The subjects assembled there for the test and after verification from the subjects that they did not take any food with more fat, 5 milliliter of venous blood was collected from each subject through venupuncture by using standard disposable syringes by the technician. The collected blood sample was taken to the lab for testing random blood sugar and the lipoproteins. After testing the blood for lipoproteins and random sugar, the data were collected from the laboratory and recorded in mg/dL. The same procedure was performed once before the experiment and next after 12 weeks after the experiment.

3.14. Training period

The experimentation was subjected to twelve weeks of walking training on different surface. Training was given five days a week for experimental groups. During every session the training lasted approximately for 60 minutes inclusive of warming up, training and limbering down process. Training was given under the direct supervision of the investigator. The control group did not participate in any organized physical activities and the training programme. All the criterion variables were tested for control and experimental groups prior and after the training period.

3.15. Precautions Followed to Avoid Injuries

The safety precaution such as wearing proper footwear and surface condition was followed to avoid injuries during experimentation. Proper warming up and stretching exercise were given to the subjects before starting the training. The subjects were walking continuously

for forty five minutes without break. The subjects performed cooling down and stretching exercises after the training to avoid injuries.

3.16. Collection of Data

During the training period the data on physiological, motor fitness and biochemical variables were collected before and after different surface walking training from experimental and control groups.

3.17. Experimental Design

The experimental design used for the present study was random group design involving 120 members as subjects. This study consisted of three experimental variable such as different surface walking training. Among the four groups, group I treated with mud walking training, group II treated with concrete walking training, group III treated with road walking training and group IV acted as control group. Each group consists of 30 subjects and they were tested prior and after twelve weeks of different surface walking training. The experimental design was covariance design. During each testing period all the criterion variables such as physiological, motor fitness and biochemical variables were tested.

3.18. Statistical Techniques

To examine the critical analysis of walking on different surfaces on selected motor fitness, physiological and biochemical variables among obese men analysis of covariance ANCOVA (*Analysis of covariance* n.d) was computed for the data collected from experimental groups and control group during pre and post test separately for each variable. As the obtained F-ratio was significant, the Scheffe's test was used as a post-hoc test to find out the significant difference between each variable. In all the cases, 0.05 level of significance was used to test the hypotheses. (Clarke & Clarke , 1972)

Chapter IV

RESULT AND DISCUSSION

This chapter deals with the statistical analysis discussion on result and interpretation of the data pertaining to the study are presented in this chapter. The purpose of the present study is analysis of different surfaces walking on motor fitness, physiological and biochemical variables among obese men. To achieve the purpose of the study, 120 obese men in the age group of 40 to 45 years were selected randomly from the walkers in Anna nagar Chennai city. The study was restricted to the following variables such as resting pulse rate, vital capacity, cardiovascular endurance, flexibility, random blood sugar, low density lipoprotein, high density lipoprotein. All the subjects were tested on the selected criterion variables. The data pertaining to the variables in this study were examined by using Analysis of Covariance (ANCOVA) for each variable separately in order to determine the differences if any, among the means. Whenever 'F' ratio was found to be significant, the Scheffe's test was used as post-hoc test to determine the cell mean differences. The level of significance was fixed at 0.05 level for all the cases.

The data thus collected before the experimental administration of the programmes were recorded as Pre Test scores. After the experimental period of 12 weeks, the measurements were made and recorded as the Pot-Test Scores. The eating habits, the profession and the economic and socio-cultural factors of the participants were not taken into account during the process of the statistical process. The collected data were subjected to ANCOVA and the results are presented below:

4.1. Data analysis for Resting pulse rate

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable resting pulse rate among the four groups and the obtained results have been presented in Table 4.1 and Table 4.2.

Table 4.1 showed that the Resting Pulse Rate was significant at .01 level of confidence with an F- ratio of 10.09. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 10.09. The value of covariance became apparent.

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4.1: ANCOVA Summary

For Resting Pulse Rate

Source	SS	df	MS	F	P
Adjusted means	174.75	3	58.25	10.09*	6E-06
Adjusted error	663.94	115	5.77		
Adjusted total	838.69	118			

*Significant at 0.05 level

Since the value of F-ratio is greater than the table value, it indicates that there was a significant difference among the means of Mud walking, Concrete walking, Road walking and the Control groups on Resting Pulse Rate. To find out which of the three paired means had a significant difference, the Scheffe's post-hoc test was applied and the results are presented in table 4.2.

Table 4.2: Ordered, adjusted Pulse Rate Means and Differences between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
80.86			83.92	3.07	23.34
	81.46		83.92	2.47	15.12
		82.93	83.92	0.99	2.43

Table 4.2 shows that the Scheffe's test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 23.34, the Road walking Group and the Control Group was 15.12 and the Concrete Walking Group and the Control Group was 2.43. The Required F value for Scheffe's test of significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F' ratio between Mud Walking group and the control group was 23.34 which is highly significant. The obtained values of F' ratio between Road Walking group and the control group was 15.12 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 2.43 which was well below the required level of confidence.

Table 4.3, which is given below, would be helpful just to compare the initial, final and adjusted means of Resting Pulse Rate and easily understand the differences between them.

Table 4.3: Initial, Final and Adjusted Means of Resting Pulse Rate for Control and Experimental Groups

Scores	Group I	Group-II	Group - III	Control
Initial	84.6	84.6	84.8	84.8
Final	80.8	82.9	81.5	84.0
Adjusted	80.9	82.9	81.5	83.9

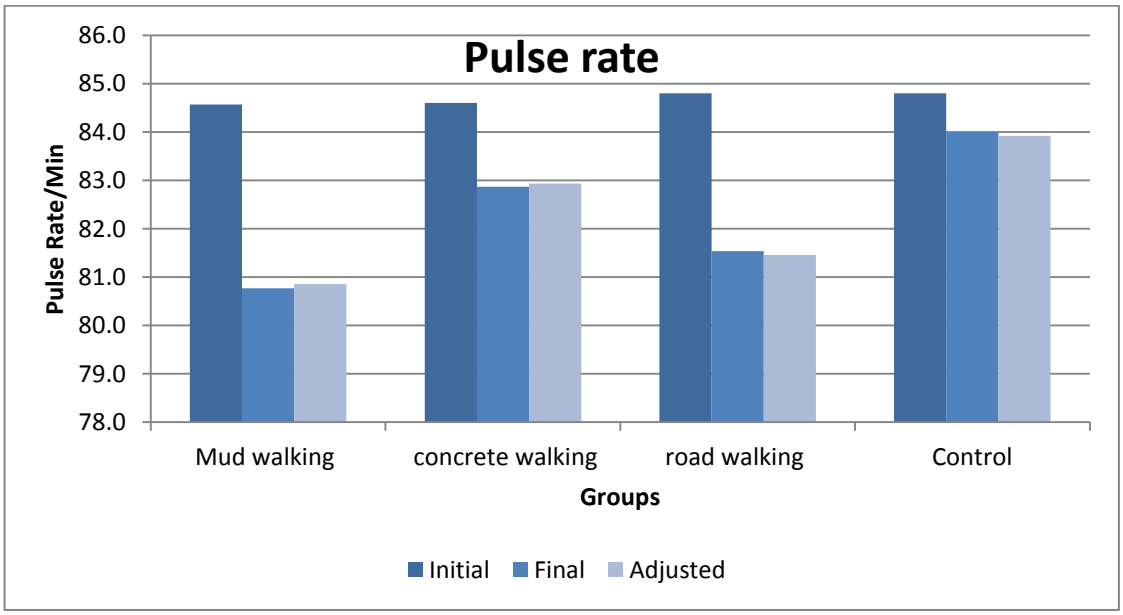

Fig. 4.1 Initial, Final and Adjusted Means of Resting Pulse Rate

On the basis of the data provided in Table 4.1, the graphical representation for better understanding of the variables had been provided. The resting pulse rate had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

4.2. Data analysis for Cardiovascular Endurance

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable cardiovascular endurance among the four groups and the obtained results have been presented in Table 4.4 and Table 4.5.

Table 4.4 showed that the cardiovascular endurance was significant at .01 level of confidence with an F- ratio of 5.14. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 6.66 and 10.10 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 5.14. The value of covariance became apparent.

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4. 4: ANCOVA Summary
for cardiovascular endurance

Source	SS	df	MS	F	P
Adjusted means	91787	3	30596	5.14*	0.002
Adjusted error	7E+05	115	5953		
Adjusted total	8E+05	118			

*Significant at 0.05 level

Since the value of F-ratio is greater than the table value, it indicates that there was a significant difference among the means of Mud walking, Concrete walking,

Road walking and the control groups on cardiovascular endurance. To find out which of the three paired means had a significant difference, the Scheffe's post-hoc test was applied and the results are presented in table 4.5.

Table 4.5: Ordered, adjusted cardiovascular endurance Means and Differences Between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
1489			1413	76.2859	14.30013
	1467		1413	53.5146	7.037139
		1458	1413	44.3557	4.834488

Table 4.5 shows that the Scheffe's test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 14.30, the Road walking Group and the Control Group was 7.03 and the Concrete Walking Group and the Control Group was 4.83. The Required F value for Scheffe's test of significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 14.30 which is highly significant. The obtained values of F' ratio between Road Walking group and the control group was 7.03 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 4.83 which was well below the required level of confidence

Table 4.6: Initial, Final and Adjusted Means of cardiovascular endurance for Control and Experimental Groups

Scores	Group I	Group-II	Group - III	Control
Initial	1393	1403	1395	1407
Final	1484	1461	1462	1420
Adjusted	1489	1458	1467	1413

The above tabulation shows the initial, final and Adjusted Final cardiovascular endurance Means for the four groups in the study.

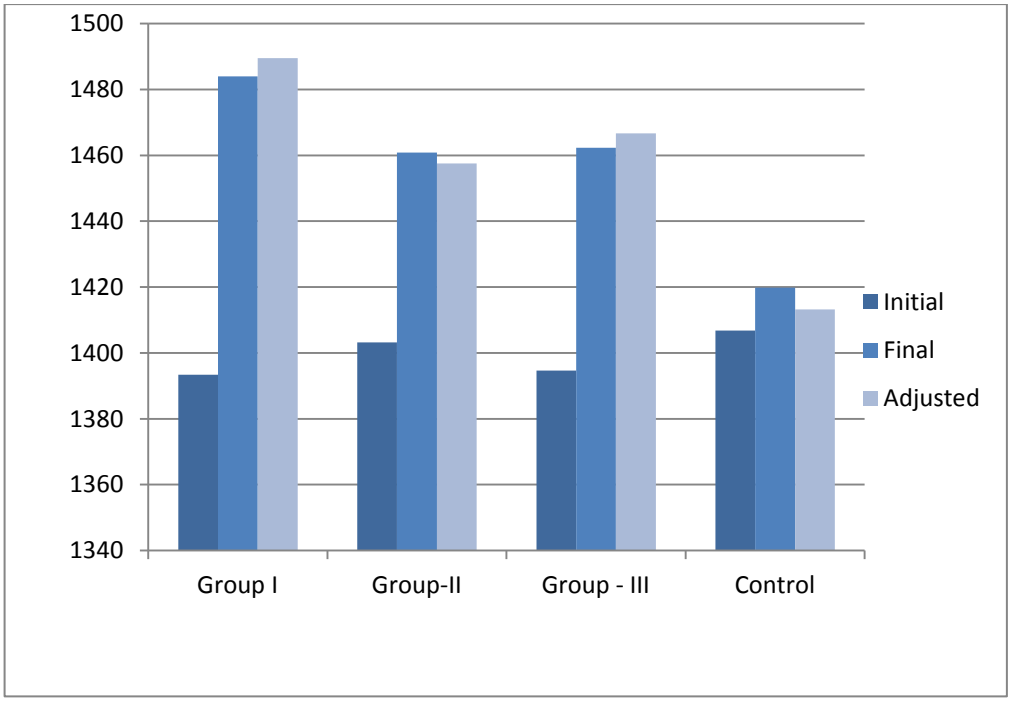

Fig. 4.2 Initial, Final and Adjusted Means of cardiovascular endurance

On the basis of the data provided in Table 4.2, the graphical representation for better understanding of the variables had been provided. The cardiovascular endurance had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

4.3. Data analysis for Vital capacity

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable vital capacity among the four groups and the obtained results have been presented in Table 4.6 and Table 4.7.

Table 4.6 showed that the vital capacity was significant at .01 level of confidence with an F- ratio of 23.22. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were

significant well beyond the .01 level, since the F ratio obtained was 23.22 The value of covariance became apparent.

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4.7: ANCOVA Summary for Vital capacity

Source	SS	df	MS	F	P
Adjusted means	28817	3	9606	23.22*	<.0001
Adjusted error	47573	115	413.7		
Adjusted total	76390	118			

*Significant at 0.05 level

Since the value of F-ratio is greater than the table value, it indicates that there was a significant difference among the means of Mud walking, Concrete walking, Road walking and the control groups on vital capacity. To find out which of the three paired means had a significant difference, the Scheffe's post-hoc test was applied and the results are presented in table 4.7.

Table 4.8: Ordered, adjusted vital capacity Means and Differences between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
377.1			333.6	43.5109	67.06929
	359.1		333.6	25.4379	22.92398
		353.5	333.6	19.8794	14.0002

The Scheffe's test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 67.06, the Road walking Group and the Control Group was 22.92 and the Concrete Walking Group and the Control Group was 14.00. The Required F value for Scheffe's test of significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 67.06 which is highly significant. The

obtained values of F ratio between Road Walking group and the control group was 22.92 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 14.00 which was well below the required level of confidence.

Table 4.9: Initial, Final and Adjusted Means vital capacity for Control and Experimental Groups

Scores	Group I	Group-II	Group - III	Control
Initial	337.3	327.3	329.7	332
Final	382.3	349.7	357.3	334
Adjusted	377.1	353.5	359.1	333.6

The above tabulation shows the initial, final and Adjusted Final cardiovascular endurance Means for the four groups in the study.

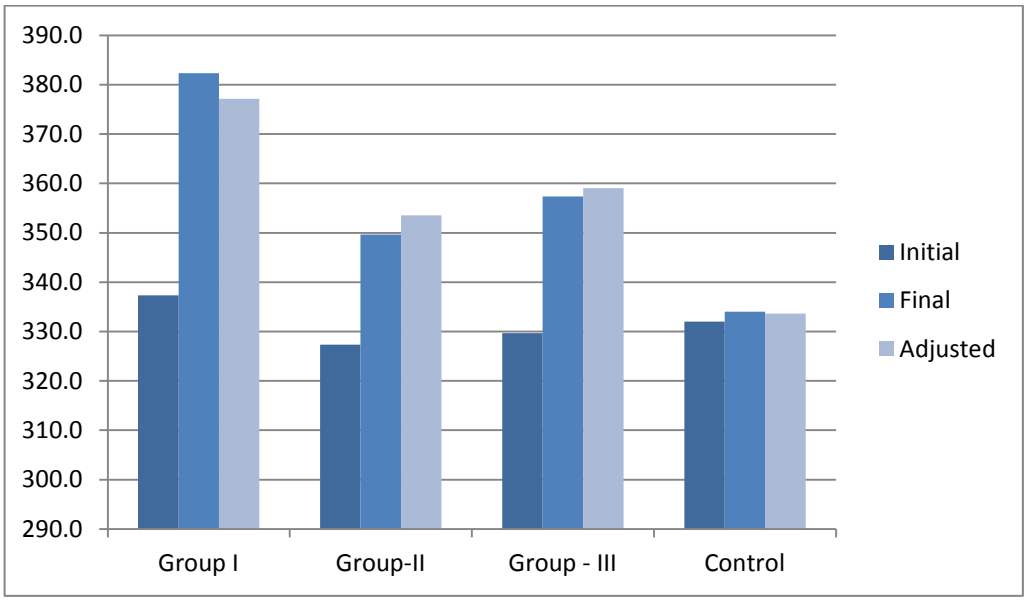

Fig.4.3. Initial, Final and Adjusted Means of vital capacity

On the basis of the data provided in Table 4.3, the graphical representation for better understanding of the variables had been provided. The vital capacity had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

4.4. Data analysis for Flexibility

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable flexibility among the four groups and the obtained results have been presented in Table 4.10 and Table 4.11.

Table 4.10 showed that the flexibility was significant at .01 level of confidence with an F- ratio of 30.17. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 30.17 The value of covariance became apparent.

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4.10: ANCOVA Summary for flexibility

Source	SS	df	MS	F	P
Adjusted means	145.9	3	48.64	30.17*	<.0001
Adjusted error	185.4	115	1.61		
Adjusted total	8E+05	118			

*Significant at 0.05 level

Since the value of F-ratio is greater than the table value, it indicates that there was a significant difference among the means of Mud walking, Concrete walking, Road walking and the control groups on flexibility. To find out which of the three paired means had a significant difference, the Scheffe's post-hoc test was applied and the results are presented in table 4.11.

Table 4.11: Ordered, adjusted flexibility Means and Differences Between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
9.467			6.478	2.9886	78.27984
	8.355		6.478	1.8771	30.88084
		7.467	6.478	0.9886	8.565556

The Scheffe's test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 78.27, the Road walking Group and the Control Group was 30.88 and the Concrete Walking Group and the Control Group was 8.56. The Required F value for Scheffe's test of significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 78.27 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 30.88 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 8.56 which was well below the required level of confidence.

Table 4.12: Initial, Final and Adjusted Means of flexibility for Control and Experimental Groups

Scores	Group I	Group-II	Group - III	Control
Initial	6.4	6.4	6.4	6.5
Final	9.5	7.5	8.3	6.5
Adjusted	9.5	7.5	8.4	6.5

The above tabulation shows the initial, final and Adjusted Final flexibility Means for the four groups in the study.

On the basis of the data provided in Table 4.4, the graphical representation for better understanding of the variables had been provided. The flexibility had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The

improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

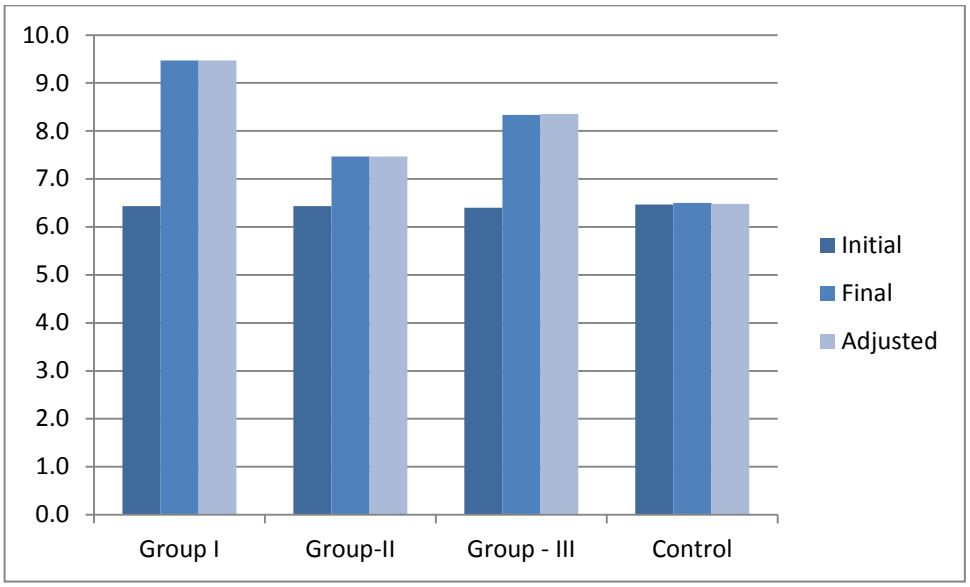

Fig. 4.4 Initial, Final and Adjusted Means of Flexibility

4.5 Data analysis for Random blood sugar

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable random blood sugar among the four groups and the obtained results have been presented in Table 4.13 and Table 4.14.

Table 4.13 showed that the random blood sugar was significant at .01 level of confidence with an F- ratio of 10.47. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 10.47 The value of covariance became apparent.

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4.13: ANCOVA Summary for blood random sugar

Source	SS	df	MS	F	P
Adjusted means	790.9	3	263.6	10.47*	4E-06
Adjusted error	2897	115	25.19		
Adjusted total	3687	118			

*Significant at 0.05 level

Since the value of F-ratio is greater than the table value, it indicates that there was a significant difference among the means of Mud walking, Concrete walking, Road walking and the control groups on random blood sugar. To find out which of the three paired means had a significant difference, the Scheffe's post-hoc test was applied and the results are presented in table 4.14.

Table 4.14: Ordered, adjusted blood random sugar Means and Differences Between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
143.1			150.2	7.101	33.25696
	145.3		150.2	4.8343	15.41383
		146.6	150.2	3.5956	8.526803

The Scheffe's test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 33.25, the Road walking Group and the Control Group was 15.41 and the Concrete Walking Group and the Control Group was 8.52. The Required F value for Sheffe S test of significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 33.25 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 15.41 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 8.52 which was well below the required level of confidence.

The following tabulation shows the initial, final and Adjusted Final random blood sugar Means for the four groups in the study.

Table 4.15: Initial, Final and Adjusted Means of random blood sugar for Control and Experimental Groups

Scores	Group I	Group-II	Group – III	Control
Initial	149.6	150.2	149.6	151.2
Final	142.6	146.6	144.8	151.1
Adjusted	143.1	146.6	145.3	150.2

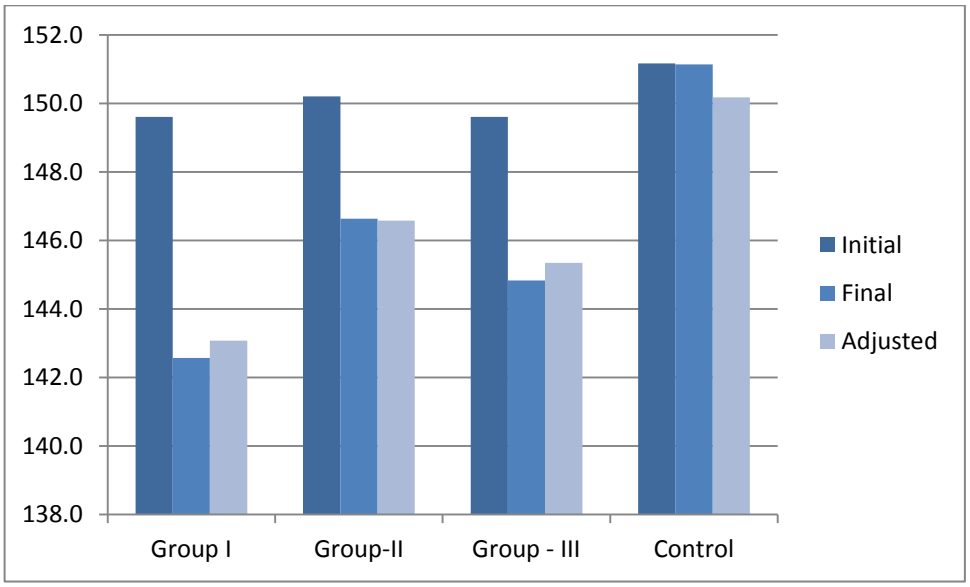

Fig. 4.5 Initial, Final and Adjusted Means of Random blood sugar

On the basis of the data provided in Table 4.15, the graphical representation for better understanding of the variables had been provided. The random blood sugar had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

4.6. Data analysis for low density lipoprotein

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable low density lipoprotein among the four groups and the obtained results have been presented in Table 4.16 and Table 4.17.

Table 4.16 showed that the variable low density lipoprotein was significant at .01 level of confidence with an F- ratio of 4.4. It explained that the mean differences were not

occurred due to chance but they differ significantly. By entering the F table with 2 and 55 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 4.4 The value of covariance became apparent.

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4.16: ANCOVA summary for low density lipoprotein

Source	SS	df	MS	F	P
Adjusted means	815.1	3	271.7	4.4*	0.006
Adjusted error	7097	115	61.72		
Adjusted total	7913	118			

*Significant at 0.05 level

Since the value of F-ratio is greater than the table value, it indicates that there was a significant difference among the means of Mud walking, Concrete walking, Road walking and the control groups on low density lipoprotein. To find out which of the three paired means had a significant difference, the Scheffe's post-hoc test was applied and the results are presented in table 4.9.

Table 4.17: Ordered, adjusted low density lipoprotein Means and Differences Between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
124.8			131.5	6.7549	12.68414
	125.7		131.5	5.8015	9.356296
		128.1	131.5	3.4185	3.248587

The Scheffe's test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 12.68, the Road walking Group and the Control Group was 9.35 and the Concrete Walking Group and the Control Group was 3.24. The Required F value for Sheffe S test of

significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 12.68 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 9.35 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 3.24 which was well below the required level of confidence.

The following tabulation shows the initial, final and Adjusted Final low density lipoprotein Means for the four groups in the study.

Table 4.18: Initial, Final and Adjusted Means of low density lipoprotein for Control and Experimental Groups

Scores	Group I	Group-II	Group - III	Control
Initial	131.9	132.2	132.2	132.3
Final	124.6	128.1	125.7	131.6
Adjusted	124.8	128.1	125.7	131.5

On the basis of the data provided in figure 4.18, the graphical representation for better understanding of the variables had been provided. The low density lipoprotein had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

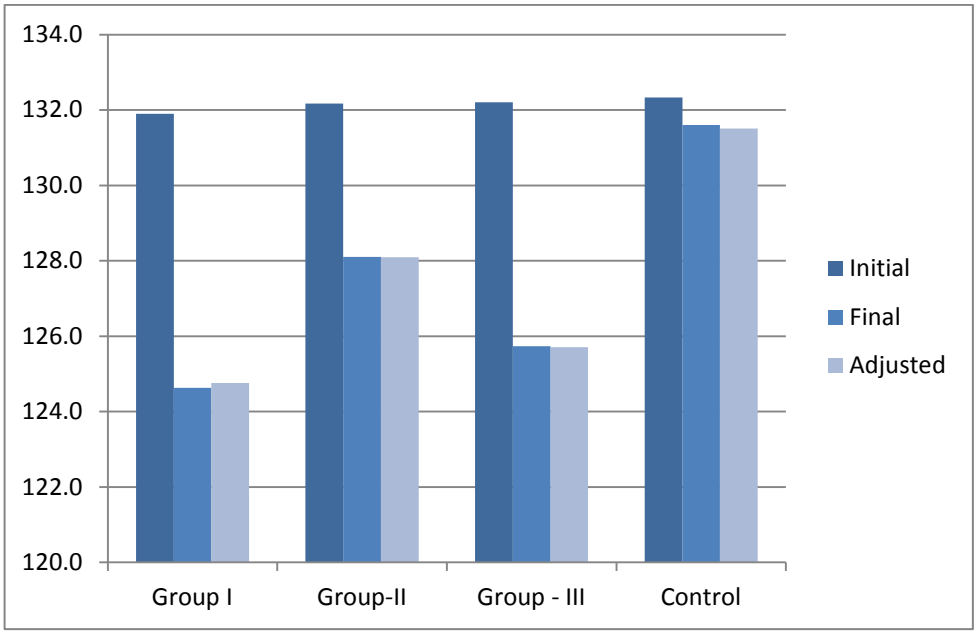

Fig. 4.6 Initial, Final and Adjusted Means of low density lipoprotein

4.7. Data analysis for high density lipoprotein

ANCOVA was applied on the performance of Mud walking, Concrete walking, Road walking and the control groups for ascertaining the significance of dependent variable high density lipoprotein among the four groups and the obtained results have been presented in Table 4.19 and Table 4.20.

Table 4.19 showed that the high density lipoprotein was significant at .01 level of confidence with an F- ratio of 13.19. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 13.19. The value of covariance became apparent.

Table 4.19: ANCOVA summary for high density lipoprotein

Source	SS	df	MS	F	P
Adjusted means	342.68	3	114.23	13.19*	<.0001
Adjusted error	995.9	115	8.66		
Adjusted total	7913	118			

*Significant at 0.05 level

The final adjustment means have not been determined as the analysis of covariance was calculated from the adjusted sum of squares. Since the F ratio was significant, the process should continue.

Table 4.20: Ordered, adjusted high density lipoprotein Means and Differences between the Means for Control and Experimental groups

Mud Walking Group	Road Walking Group	Concrete Walking Group	Control Group	Mean Difference	F- Ratio
51.262			46.775	4.4865	33.5534
	50.413		46.775	3.6374	22.05481
		49.184	46.775	2.4082	9.667323

The Scheffe' S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 33.55, the Road walking Group and the Control Group was 22.05 and the Concrete Walking Group and the Control Group was 9.66. The Required F value for Scheffe' S test of significance for 3 and 115 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 33.55 which is highly significant. The obtained values of F ratio between Road Walking group and the control group were 22.05 which were also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 9.66 which were well below the required level of confidence.

Table 4.21: Initial, Final and Adjusted Means of high density lipoprotein For Control and Experimental Groups

Scores	Group I	Group-II	Group - III	Control
Initial	46.3	46.3	46.4	46.6
Final	51.2	49.1	50.4	46.9
Adjusted	51.3	49.2	50.4	46.8

The above tabulation shows the initial, final and Adjusted Final low density lipoprotein Means for the four groups in the study.

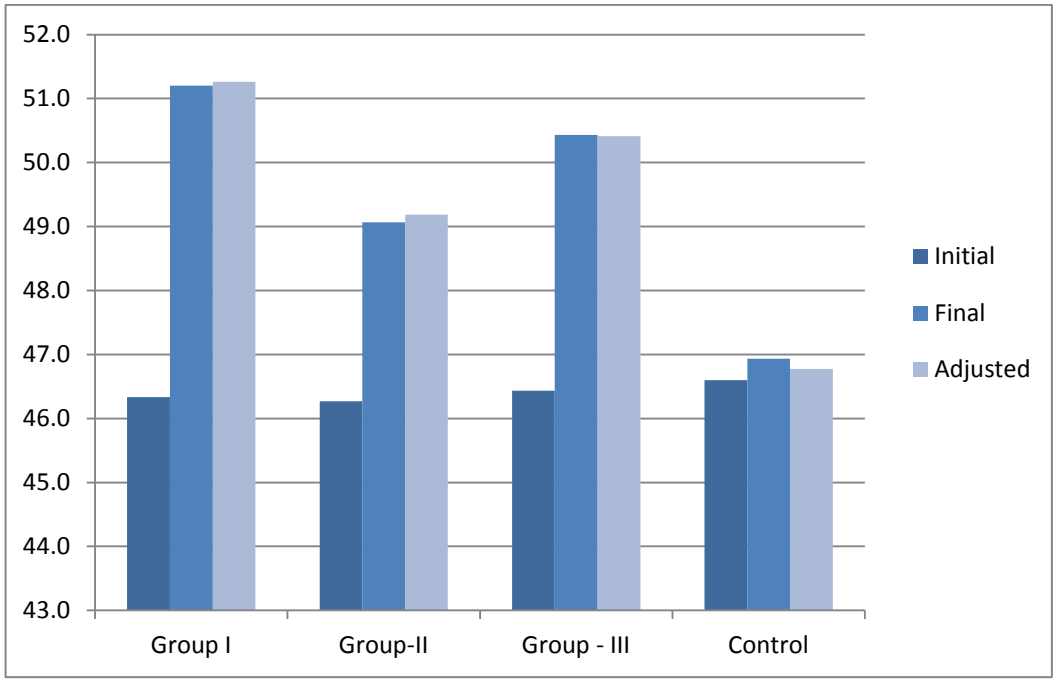

Fig. 4.7 Initial, Final and Adjusted Means of high density lipoprotein

On the basis of the data provided in Table 4.21, the graphical representation for better understanding of the variables had been provided. The high density lipoprotein had been improved better by the mud walking group, road walking group and the concrete walking group. These mean differences had been established using the statistical techniques. The improvement in the means was not just by chance but only due to the experimental treatments the groups underwent.

4.8. Discussion on Findings

4.8.1. Discussion on pulse rate

The results of the present study reveal that the experimental group has significantly increased pulse rate as compared to control group. The finding of the study is in line with the findings of Morris et al (1997) suggested that six week of walking training has improved resting pulse rate.

4.8.2. Discussion on cardiovascular endurance

The results of the present study reveal that the experimental group has significantly increased cardiovascular endurance as compared to control group. The finding of the study is in line with the findings of Schulz et al. (2015) examined that six weeks of walking has significantly increased endurance.

4.8.3. Discussion on vital capacity

The results of the present study reveal that the experimental group has significantly increased vital capacity as compared to control group. The finding of the study is in line with the findings of Dominelli, Sheel and Foster (2012) examined that twelve weeks of Physical activity has significantly increased vital capacity.

4.8.4. Discussion on flexibility

The results of the present study reveal that the experimental group has significantly increased flexibility as compared to control group. The finding of the study is in line with the findings of Mahalingam and Vairamani (2015) examined that twelve weeks of walking has significantly increased flexibility.

4.8.5. Discussion on Random blood sugar

The results of the present study reveal that the experimental group has significantly increased random blood sugar as compared to control group. The finding of the study is in line with the findings of Nishida et al (2010) examined that six weeks of low density exercise has significantly reduced sugar level.

4.8.6. Discussion on low density lipoprotein

The results of the present study reveal that the experimental group has significantly increased low density lipoprotein as compared to control group. The finding of the study is in line with the findings of Aguilo Antoni, and others (2003) that the different intensity of exercise has significantly reduced the low density lipoprotein

4.8.7. Discussion on high density lipoprotein

The results of the present study reveal that the experimental group has significantly increased high density lipoprotein as compared to control group. The findings of the study is in line with the findings of Couillard et al., (2001) suggested that regular training has significantly increase the high density lipoprotein (HDL).

4.9. Discussion on hypothesis

It was hypothesized that during the training period, there would be significant improvement on selected motor fitness, Physiological and biochemical variables for experimental groups when compare to control group. It was inferred in this study that all the motor fitness, physiological and biochemical variables have improved significantly for experimental group. Hence, the hypothesis is true.

Chapter V

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Walking is a natural activity from our birth and the locomotion from one place to other place is walking. Walking is good and easy exercise compared to other fitness training and that is why all the doctors direct their patients to go for walking. But most of the people are thinking that walking is a simple exercise and there will not be much benefit. Some may go for walking for two or three days or one or two weeks and then they stop the walking because of no improvement or weight loss. The people are not thinking about how long it takes to get their weight reduced. There is a 100 % chance to improve the fitness level and weight loss with the help of walking.

Now it is very obvious that the problem we face today due to the prevalence of diabetes, hypertension and the like is due to our own activities. They are not infectious and so we have not derived them from anybody else. They are like accidents and they just do not happen but they are caused due to careless approach to our ways of living. We should understand that health and physical fitness play a fundamental role in the life of human from time immemorial. The progress of the Nation lies in the hands of the people, who are healthy and physically fit. Every individual have to develop physical fitness and lead a happy and healthy life. It is very simple that to get physical fitness one has to involve in physical activities.

Obesity is a social problem which begets many more non-infectious troubles to the body mechanisms. The reasons for this social evil might be attributed to heredity and the host of other habits like over eating and sedentary life styles. The lifestyle changes have played a very great role in many developed countries and the life style changes are ascribed to advancement in science and technology. The science and technology is fulltime striving to provide a better and comfortable life. At the same time the curse of obesity is recognized to the lack of physical work and lack of physical work is linked to the developed and easier comfortable lifestyle.

If the above health hazard is true in urban and semi urban areas in Tamil Nadu, a part of developing India, the same trend is now found very much in prevalent in rural south Tamil Nadu. People have become moderately lazy by sitting in front of Televisions and discussing politics and like. The reasons mainly are pointed to the lack of their farming work. The lack of farming work may be due to the shrinking of cultivable land and the non-productive and loss making agriculture.

The urban and semi urban people who have the knowledge of sedentary life style, the physical problems they get due to their eating habits and laziness, have a lot of guidance and counselling from the medical professional and hospitals. But, the people who live in the rural background, not knowing the reasons of their problems, eat what they get and do not care to visit a doctor and get his guidance.

People are in search of an easiest way to reduce their size, weight and eat less to keep the sugar level in control. But they are not aware of the fact that the simplest way of keeping control over the above problems is just walk. Walking is mindlessly shifting one leg ahead of the other and the speed, intensity and the distance are under the personal control of the walker. If you are in a pleasant mood and energetic, you can walk for 50 minutes faster and cover a distance of 4 to 5 kilometers. If you are tired and not inclined to do more, it is up to you to choose the speed and intensity of your walking and the distance travelled is under your own wish. The people must be aware of the fact that if they walk a small distance spending more time is almost equal to covering a long distance in short time, in terms of the calories spent.

Taking into consideration walking, a simple form of exercise, in to the fold of their daily routine, the problems of obesity, sugar and other problems could be kept under control. Many researchers strongly support that regular walking helps one keep strong and healthy and prevent cardio- vascular diseases. The heart beats of a physically fit person are lower and pumps more blood per beat at rest. Regular walking increases the individual's capacity of lungs and heart

Now the scholar think about the surfaces, just ten years back everywhere full of mud ground even including parks. But now all the parks are changed to concrete foot paths most of the street roads are done by concrete, so the scholar plan to study about the surfaces and which surface is use full for the people. Generally peoples are walking in three surfaces now a day's, one is walking on the mud, second one is concrete and third one is road

walking. Mostly who where all don't have the park near by their home, they will go for road walking.

Regular walking can improve confidence, stamina, energy, weight control and life expectancy and reduce the risks of heart related disorders. Walking also improves strength of bone, especially strengthening the hip bone, and lowering the harmful low-density lipoprotein (LDL) cholesterol, and raising the useful high-density lipoprotein (HDL) cholesterol

5.1. Summary

The aim of this study was to provide three different surfaces to sensitize male population about the other physical activities which may contribute for their fitness avoiding monotony of activity thereby helping them to find peace and immunity, improved abilities and processing efficiency with their abilities and skills. The scholar tried mud surface to one experimental group, road surface to the next experimental group and a concrete surface to another experimental group. It would contribute to the society at large to have a healthy and active life if the experiments in the study are proved encouraging and the prescription of the best surface for walking would benefit the society at large.

The aim of this study was to find out the different surfaces walking on motor fitness, physiological variables and biochemical variables among obese men, that too which surface was giving more impact and more benefits for the normal, middle class people. Because who are all rich they go for gym and they walk in their home itself with the help of treadmill. This study would contribute to the society at large to have a healthy and active life if the experiments in the study are proved encouraging.

In the present study an effort was made to select the subjects among the obese people from Chennai city, Tamil Nadu. The subjects were directed to assemble in a park to seek their willingness. The investigator explained to them the purpose, importance of experiment and the procedure to be employed to collect the blood. Further, the role of subjects during experimentation and testing period were also explained. Hundred and twenty subjects were selected by random sampling technique. Their age ranged from 40 to 45 years. All the subjects were over healthy. The subjects were divided in to four equal groups of thirty each at random method. There were no dropouts in the study and the entire subjects cooperated well during the experimentation and testing periods.

5.2. The purposes of this study

1. To explore the improvement on chosen To find out the effects of Walking on different surfaces on selected Biochemical, motor fitness and physiological variables among obese men.

2. To examine how far the experimental group experienced changes on motor fitness selected and physiological, biochemical, variables during the training period.

The criterion variable selected in the study Bio chemical, Motor fitness and physiological variables. i) Random blood sugar ii) Low density lipoprotein iii) High density lipoprotein I) Cardiovascular endurance, ii) Flexibility, i) Resting pulse rate ii) Vital capacity and the standard test were used to asses these variable.

The experiment was conducted for a period of 12 weeks and the data on the selected variables were collected before and after the experimental period and the collected data were analyzed using ANCOVA and the mean differences among the pre and post tests of the variables were established.

5.3. Conclusions

It has been scientifically accepted that any systematic training over a continuous period of time would lead to produce changes on athletic qualities. Based on this concept and research questions the following research hypotheses were formulated and it was tested at 0.05 level of confidence. On the basis of the study the following conclusions were drawn:

The Resting Pulse Rate was significant at .01 level of confidence with an F- ratio of 10.09. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 10.09. The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 23.34, the Road walking Group and the Control Group was 15.12 and the Concrete Walking Group and the Control Group was 2.43. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F' ratio between Mud Walking group and the control group was 23.34

which is highly significant. The obtained values of F' ratio between Road Walking group and the control group was 15.12 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 2.43 which was well below the required level of confidence.

The cardiovascular endurance was significant at .01 level of confidence with an F-ratio of 5.14. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 6.66 and 10.10 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 5.14. The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 14.30, the Road walking Group and the Control Group was 7.03 and the Concrete Walking Group and the Control Group was 4.83. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 14.30 which is highly significant. The obtained values of F' ratio between Road Walking group and the control group was 7.03 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 4.83 which was well below the required level of confidence.

The vital capacity was significant at .01 level of confidence with an F- ratio of 23.22. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18and 5.05 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 23.22 The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 67.06, the Road walking Group and the Control Group was 22.92 and the Concrete Walking Group and the Control Group was 14.00. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 67.06 which is highly significant. The obtained values of F ratio between Road Walking group

and the control group was 22.92 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 14.00 which was well below the required level of confidence.

The flexibility was significant at .01 level of confidence with an F- ratio of 30.17. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 30.17 The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 78.27, the Road walking Group and the Control Group was 30.88 and the Concrete Walking Group and the Control Group was 8.56. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 78.27 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 30.88 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 8.56 which was well below the required level of confidence.

The random blood sugar was significant at .01 level of confidence with an F- ratio of 10.47. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 3 and 115 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 10.47 The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 33.25, the Road walking Group and the Control Group was 15.41 and the Concrete Walking Group and the Control Group was 8.52. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 33.25 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 15.41 which was also highly significant at .01 level of

confidence. But the F ratio between Concrete Walking Group and the Control Group was 8.52 which was well below the required level of confidence.

The variable low density lipoprotein was significant at .01 level of confidence with an F- ratio of 4.4. It explained that the mean differences were not occurred 7due to chance but they differ significantly. By entering the F table with 2 and 55 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 4.4 The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 12.68, the Road walking Group and the Control Group was 9.35 and the Concrete Walking Group and the Control Group was 3.24. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 12.68 which is highly significant. The obtained values of F ratio between Road Walking group and the control group was 9.35 which was also highly significant at .01 level of confidence. But the F ratio between Concrete Walking Group and the Control Group was 3.24 which was well below the required level of confidence.

The high density lipoprotein was significant at .01 level of confidence with an F-ratio of 13.19. It explained that the mean differences were not occurred due to chance but they differ significantly. By entering the F table with 2 and 55 df to determine the F ratios required for significance; these ratios were 3.18 and 5.05 at 0.05 and 0.01 levels respectively for 2 and 55 df. Thus, the differences among the four final adjusted means were significant well beyond the .01 level, since the F ratio obtained was 13.19. The value of covariance became apparent. The Sheffe S test was used for testing the significance between the paired adjusted means. The obtained F- ratios between the Mud Walking group and the control group were 33.55, the Road walking Group and the Control Group was 22.05 and the Concrete Walking Group and the Control Group was 9.66. The Required F value for Sheffe S test of significance for 2 and 55 df are 6.36 and 10.10. The obtained values of F ratio between Mud Walking group and the control group was 33.55 which is highly significant. The obtained values of F ratio between Road Walking group and the control group were 22.05 which were also highly significant at .01 level of

confidence. But the F ratio between Concrete Walking Group and the Control Group was 9.66 which were well below the required level of confidence.

5.4. Feedback from the subjects of study:

1. The mud walking group members expressed at the end of the training period that they felt light and more flexible. They were confident that this walking would help them in reducing their body weight and help them in performing their daily work with ease.

2. The concrete walking group also expressed their feeling that they had their weight reduced to some extent but they felt some pain in the joints after walking daily.

3. The subjects who walked on road expressed their opinion that walking on roads was a bit difficult due to traffic and they were unable to maintain their continuous intensity of walking. But they did not complain any pain or discomfort due to the training

All the subjects were very happy and felt confident in continuing their walking process regularly as done during their experiment. It was very heartening to note here that the scholar was satisfied that his study had penetrated into the society through this small group of 120 people. He was confident that the experimental group of 120 might make this a walking movement with more people joining with them.

5.5. Recommendations

On the basis of the findings of the study, the following recommendations were made:

1. This study with a large population might bring out more insight into the selection of surfaces for walking.

2. The intensity of walking had not been very much followed in the current study and that could be taken with another study with different age group.

3. The same study could be done among school boys and girls

4. The study could be restricted to obese adolescent boys and girls with addition of diet regulation and walking intensity.

5. The fitness trainers, coaches and physical educators could recommend for people to walk on mud surfaces for better results.

6. All the parks in the city should have a firm mud path for walking instead of concretizing the paths for the sake of less maintenance.

7. The schools and colleges should make it known to their students that mud walking would yield better result for fitness improvement.

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Appendix I

Raw Scores of Resting pulse rate

Group - I Mud walking		Group - II Concrete Walking		Group - III Road Walking		Group - IV Control Group	
Low density lipoprotein							
Initial	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
120	118	136	120	135	102	130	131
135	128	137	125	150	120	104	104
136	125	139	120	130	130	140	139
121	120	139	120	132	126	130	137
115	110	135	123	136	110	125	125
130	120	141	130	130	120	123	132
126	123	142	120	129	115	130	130
125	138	143	130	120	125	130	119
136	126	140	125	120	118	118	120
150	140	146	140	135	130	120	119
120	116	140	120	137	135	122	122
134	134	126	134	125	124	124	130
125	120	132	132	135	135	126	120
124	118	130	130	130	130	128	126
115	110	126	116	130	120	130	130
154	126	129	126	120	110	132	131
100	105	132	125	126	115	134	132
135	120	130	120	130	130	136	134
136	129	130	129	130	130	138	139
120	120	140	145	155	140	140	130
160	150	160	150	125	142	142	142
146	135	101	140	136	135	144	139
147	130	100	130	130	140	146	143
135	129	135	132	140	125	148	149
126	110	140	130	142	140	148	148
140	125	120	125	145	130	150	150
136	130	130	130	120	120	135	136
132	126	110	126	120	115	130	126
138	128	130	130	128	120	132	130
140	130	126	120	145	140	135	135

Appendix II

Raw Scores of Cardiovascular endurance

Group - I Mud walking		Group - II Concrete Walking		Group - III Road Walking		Group - IV Control Group	
CV Endurance							
Initial	Final	Initial	Final	Initial	Final	Initial	Final
1250	1300	1320	1350	1400	1460	1400	1650
1200	1300	1350	1400	1350	1400	1350	1680
1300	1400	1410	1560	1320	1400	1250	1320
1260	1300	1240	1300	1380	1390	1260	1270
1520	1600	1480	1600	1430	1500	1320	1400
1200	1300	1060	1090	1150	1290	1300	1250
1450	1500	1380	1430	1250	1300	1420	1510
1360	1460	1290	1350	1360	1450	1600	1500
1490	1550	1460	1560	1550	1600	1520	1540
1560	1600	1490	1530	1460	1550	1620	1555
1420	1600	1560	1450	1290	1360	1530	1610
1540	1650	1620	1700	1560	1680	1190	1120
1350	1450	1350	1400	1490	1560	1460	1510
1253	1230	1320	1400	1390	1450	1390	1290
1320	1400	1250	1350	1220	1360	1230	1350
1050	1100	1110	1250	1450	1590	1360	1420
1560	1680	1460	1560	1360	1460	1520	1560
1340	1450	1380	1450	1505	1510	1310	1430
1650	1750	1620	1550	1435	1560	1325	1320
1540	1720	1300	1350	1625	1700	1455	1490
1320	1450	1380	1420	1365	1450	1265	1290
1326	1460	1420	1500	1260	1350	1400	1450
1452	1530	1530	1600	1260	1300	1395	1260
1550	1650	1400	1550	1320	1400	1240	1365
1380	1460	1455	1550	1620	1700	1460	1240
1520	1698	1590	1590	1560	1600	1320	1120
1430	1550	1260	1325	1550	1450	1610	1680
1320	1400	1610	1560	1590	1600	1360	1360
1630	1680	1600	1650	1320	1350	1720	1730
1260	1300	1400	1450	1020	1100	1625	1325

Appendix III

Raw Scores of Vital capacity

Group - I Mud walking		Group - II Concrete Walking		Group - III Road Walking		Group - IV Control Group	
Vital capacity							
Initial	Final	Initial	Final	Initial	Final	Initial	Final
360	420	210	220	280	300	300	280
300	360	240	250	260	310	280	300
380	460	390	400	360	400	360	360
460	450	350	390	320	350	350	340
320	340	290	300	320	350	360	370
340	350	410	440	340	350	360	350
380	380	320	390	330	350	340	340
360	400	360	380	350	350	340	360
340	420	290	300	340	390	340	350
380	400	370	400	360	390	350	360
400	480	360	380	320	350	320	310
360	450	320	320	320	350	360	370
320	390	290	320	320	340	340	350
330	320	370	380	340	390	360	340
350	400	360	360	350	390	330	330
340	390	270	320	330	380	320	340
310	350	350	390	320	380	350	340
350	410	280	290	340	380	320	330
390	400	290	310	380	430	340	340
320	320	360	400	390	400	310	320
290	330	340	370	350	360	320	330
310	360	310	350	350	360	310	300
360	400	290	320	340	390	360	320
300	360	330	370	320	320	340	340
280	320	310	320	300	300	290	320
260	350	340	360	260	300	300	320
290	330	260	260	320	330	320	320
280	350	390	390	290	320	310	310
350	400	380	410	350	360	360	340
310	380	390	400	340	350	320	340

Appendix IV

Raw Scores of Flexibility

Group - I Mud walking		Group - II Concrete Walking		Group - III Road Walking		Group - IV Control Group	
Flexibility							
Initial	Final	Initial	Final	Initial	Final	Initial	Final
7	8	6	7	8	10	5	9
6	7	7	7	6	6	6	7
8	10	5	6	7	10	5	7
6	9	4	4	8	9	5	5
5	8	8	5	6	9	9	9
9	10	9	10	7	10	6	6
7	10	5	6	8	10	5	5
9	11	5	7	9	10	8	8
8	10	8	12	6	8	9	9
2	6	9	9	8	8	5	5
4	8	4	4	5	8	6	5
5	9	8	10	6	9	9	8
6	9	4	6	9	9	4	5
8	12	7	9	6	9	5	5
8	12	4	6	9	10	8	8
6	9	5	8	6	9	6	6
6	9	6	5	5	6	6	8
8	11	7	10	6	9	8	7
9	12	6	9	5	8	7	8
4	8	8	10	6	8	4	5
6	9	9	9	5	6	4	4
5	9	4	6	4	9	7	5
9	12	5	7	8	9	8	5
4	9	5	7	6	8	5	6
5	8	9	6	5	5	7	5
9	12	6	5	5	7	6	6
8	10	8	8	4	8	8	8
7	11	8	11	6	6	8	5
4	8	8	8	4	8	7	7
5	8	6	7	9	9	8	9

Appendix V

Raw Scores of Random Blood sugar

Group - I Mud walking		Group - II Concrete Walking		Group - III Road Walking		Group - IV Control Group	
Random blood sugar							
Initial	Final	Initial	Final	Initial	Final	Initial	Final
154	150	154	150	146	142	165	160
156	148	156	148	144	144	165	162
158	154	176	180	170	158	177	177
157	154	174	177	168	167	178	178
156	152	172	174	165	162	172	172
155	150	170	171	162	152	170	172
154	150	168	168	144	140	165	154
156	148	166	165	148	144	164	150
158	144	164	162	145	144	162	164
159	146	162	160	154	150	159	160
162	162	160	156	148	144	140	150
163	145	158	154	168	162	160	158
164	162	156	152	160	150	155	156
169	152	154	150	162	148	160	160
165	138	156	148	165	150	150	155
149	140	150	146	142	144	140	149
151	145	148	144	140	144	140	142
147	138	146	140	144	144	147	146
146	144	144	136	168	160	146	145
143	140	142	138	149	140	144	145
145	138	146	138	150	148	158	156
141	128	138	140	146	142	145	150
140	130	136	130	144	144	140	142
139	135	144	140	145	140	134	132
136	140	132	135	132	130	138	136
135	132	130	118	138	130	130	131
134	130	128	110	139	135	130	132
133	128	126	125	140	137	135	136
132	124	124	120	128	120	134	134
131	130	126	124	134	130	132	130

Appendix VI

Raw Scores of Low density lipoprotein

Group - I Mud walking		Group - II Concrete Walking		Group - III Road Walking		Group - IV Control Group	
Low density lipoprotein							
Initial	Final	Initial	Final	Initial	Final	Initial	Final
120	118	136	120	135	102	130	131
135	128	137	125	150	120	104	104
136	125	139	120	130	130	140	139
121	120	139	120	132	126	130	137
115	110	135	123	136	110	125	125
130	120	141	130	130	120	123	132
126	123	142	120	129	115	130	130
125	138	143	130	120	125	130	119
136	126	140	125	120	118	118	120
150	140	146	140	135	130	120	119
120	116	140	120	137	135	122	122
134	134	126	134	125	124	124	130
125	120	132	132	135	135	126	120
124	118	130	130	130	130	128	126
115	110	126	116	130	120	130	130
154	126	129	126	120	110	132	131
100	105	132	125	126	115	134	132
135	120	130	120	130	130	136	134
136	129	130	129	130	130	138	139
120	120	140	145	155	140	140	130
160	150	160	150	125	142	142	142
146	135	101	140	136	135	144	139
147	130	100	130	130	140	146	143
135	129	135	132	140	125	148	149
126	110	140	130	142	140	148	148
140	125	120	125	145	130	150	150
136	130	130	130	120	120	135	136
132	126	110	126	120	115	130	126
138	128	130	130	128	120	132	130
140	130	126	120	145	140	135	135

Appendix VII

Raw Scores of High density lipoprotein

Group - I Mud walking		Group - II Concrete Walking		Group – III Road Walking		Group - IV Control Group	
HDL							
Initial	Final	Initial	Final	Initial	Final	Initial	Final
46	56	43	44	51	56	43	43
42	52	51	52	46	53	52	52
53	59	46	48	42	50	48	48
50	53	42	40	56	59	46	42
53	56	56	56	50	56	48	52
51	52	45	48	55	58	50	53
45	52	55	60	51	52	46	45
46	52	45	52	46	48	46	46
47	50	42	52	47	49	47	45
48	50	45	50	50	55	44	50
49	51	49	51	49	53	49	49
51	57	53	54	53	55	47	50
42	47	42	45	42	44	42	40
45	49	45	46	45	49	43	42
46	48	46	46	46	52	45	45
44	48	44	45	45	46	44	46
42	50	42	42	42	42	42	42
41	48	41	42	41	46	52	50
40	45	40	45	40	45	51	51
39	42	39	40	40	48	46	46
46	52	46	48	46	48	47	48
42	45	47	45	47	48	48	50
40	50	48	55	42	50	49	48
50	55	49	52	49	55	53	54
46	52	53	54	53	48	42	42
42	50	46	46	42	42	42	42
52	52	40	49	45	52	46	40
50	53	46	52	46	50	48	50
52	55	52	58	44	45	46	49
50	55	50	55	42	59	46	48

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- Shunmugakumar, M & Sankaran, K 2015, ' Effect of walking on different surfaces on selected motor fitness and physiological variables among obese school boys', *International Journal of Applied Engineering Research Issues*, vol. 10,no.10, pp. 24301-24306 (scopus)
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- Shunmugakumar, M "Contemporary issues in sports management" at Dr. MGR Educational and Research institute University Maduravoyal, Chennai, on 29-30 April 2013

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A THESIS

Submitted by

SHUNMUGAKUMAR M

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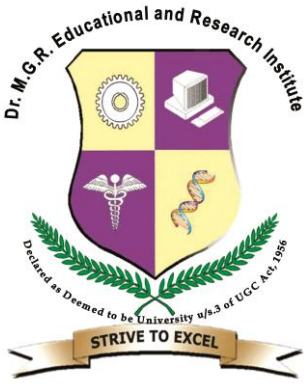

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‘I'm fat, but I'm thin inside... there's a thin man inside every fat man’.

<<< George Orwell